CHEMICAL & METALLURGICAL ENGINEERING

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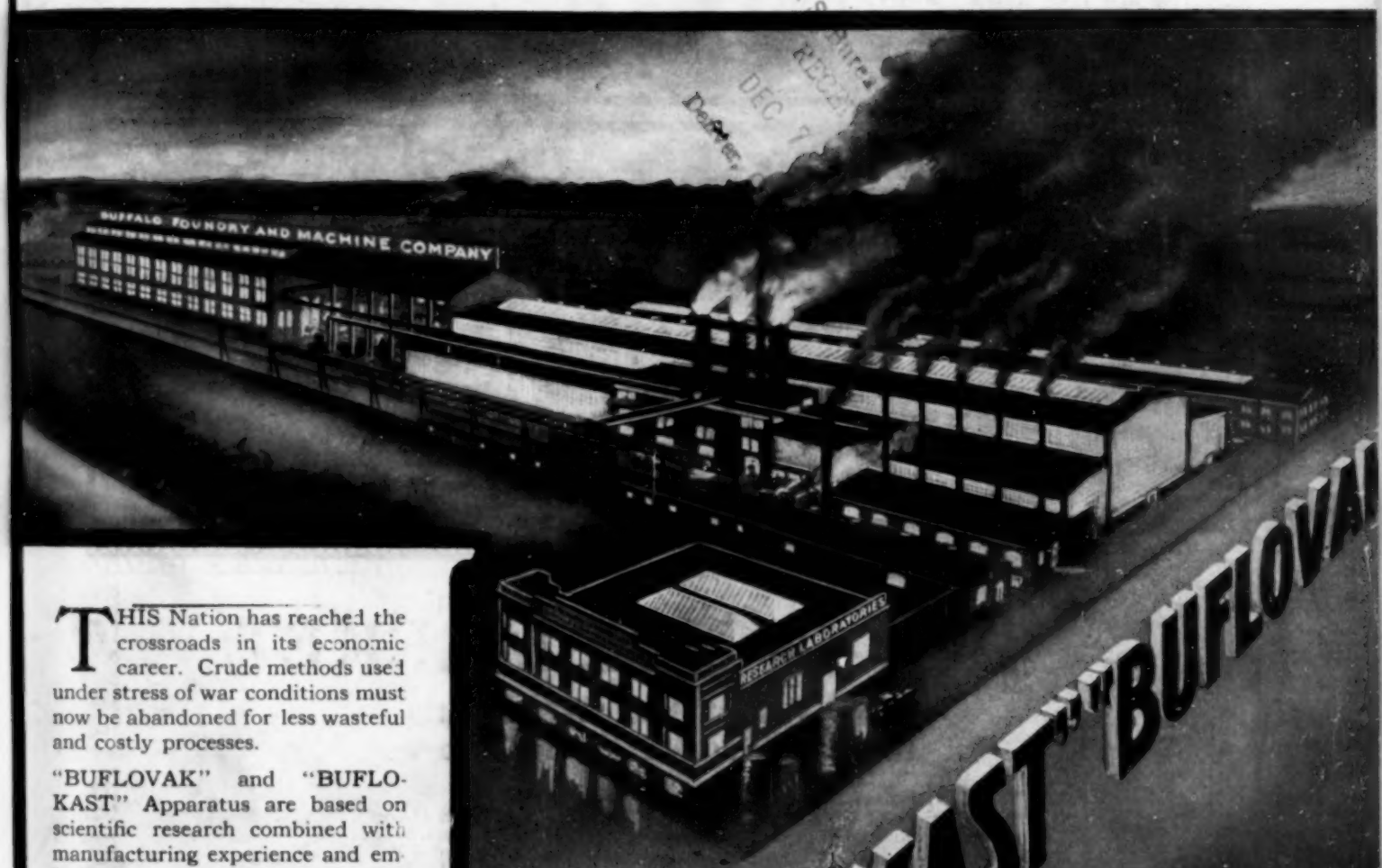

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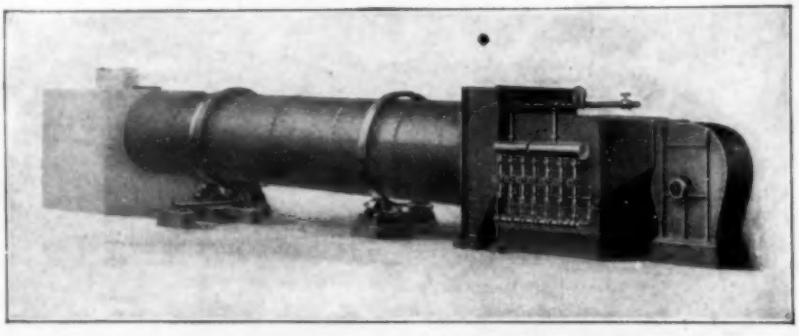

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The Reconstruction Conference To Be Held at Atlantic City

IN our last issue we called attention to the War Emergency and Reconstruction Conference to be held at Atlantic City on Dec. 4, 5 and 6. Now we urge our readers who are engaged in industries affected by the war to put in appearance if possible. It is a meeting of the 380 or more War Service Committees and the Chamber of Commerce of the United States, under the auspices of which it is called. These various committees have been consolidated into thirty-five groups which foregather separately on Dec. 4. Then they are merged into ten major groups which meet separately on Dec. 5 and in conclusion they come together for final action on Dec. 6. In the meantime a number of general sessions will be held in the Great Hall of the Million Dollar Pier at which eminent speakers will be present and make addresses. They will be open to the public.

A questionnaire containing twenty-five leading queries has been sent out by Mr. W. H. MANSS, director of the War Service Executive Committee, to all members of the War Service Committees. These cover a wide field and relate to definite problems such as unfilled orders for war materials, skilled and unskilled labor, financing, methods of canceling war orders, disposition of war materials, the continuation of the War Industries Board, control of materials during reconstruction, demand for finished products under peace conditions, raw materials, cost accounting, conservation, elimination of unnecessary products and wasteful practices, the requirements for the rehabilitation of allied countries and what we can supply until they are rehabilitated, the merchant marine, foreign competition, the Webb-Pomerene bill, etc.

The urgent need of careful and constructive thought on these and other matters is too evident to call for discussion, because legislation is certain, and if the leaders of industry do not agree upon plans we shall have to meet laws that are made without plans. With no disrespect toward Congress, we know that most of its members are lawyers, that very few of them are men of industrial experience, that sound economists are rare among them, that all must of necessity engage in politics, that politics addresses itself to what is called window-dressing—that is, to making the measures supported appeal to the popular fancy—and that industry has an entirely different task, which is to furnish the goods.

It is necessary, therefore, that whatever legislation is proposed be offered with good reason and that undue advantage for any industry shall not be sought at the expense of the general welfare. If it is, legislators

should not support it, and the best of them will not. On the other hand, if the measures proposed be conceived in a broad, patriotic spirit, with the general welfare of the people constantly in view, then politicians will vie with one another in coming to their support.

Many problems other than those involving legislation are to be considered, as those mentioned indicate. We cannot let them lie, thinking they will take care of themselves. If we do not look after them they will run away from us, and leave us stranded.

A Grinding Problem That Crushed an Editor

LUTHER W. LENNOX contributed a very noteworthy paper to the Colorado meeting of the American Institute of Mining Engineers on the "Crushing Resistance of Various Ores," giving his method of obtaining a number which represents the relative difficulty in grinding rock. This factor is evidently so useful in the solution of various problems in reducing mill feed that the author received many well-deserved compliments on his neat and simple method.

One member pointed out, however, that the title was rather illy chosen, since the method compares the work necessary to reduce a 10-mesh feed, which operation the mill-man terms "grinding," reserving the word "crushing" to denote the operation of breaking mine-run to granules. Considerable merriment was provoked by Mr. Lennox's rejoinder that his original manuscript used the word "grinding" exclusively, but that the editor saw fit to change this word to "crushing" in each instance, despite his protest.

A conscientious editor naturally wonders how directly this pointed expression of disapproval applies to his own work. Men occupying the high literary places have so often expressed their disgust with the inelegant spoken and written language of the average American engineer that the technical man has almost come to accept their words at their face value. Very true, few engineers can write with Macaulay's clarity, Stevenson's absorbing interest, or Clemens' wit; but, indeed, where is the editor who can? And there is a lurking suspicion in the mind of the man on the job that the farther up in the clouds of literary expression the writer flies, the poorer his vision of the ordinary details of making the enterprise earn dividends!

Perhaps we editors are fussing too much over nomenclature; too much horrified at the split infinitive; insisting too strongly on our individual predilections for those intangible elements of "style." The other fellow's style may be as good as ours—a shiny boot, while correct for city wear, is a poor working shoe. When we rub elbows with the busy successful engineer with a coveted store of knowledge, our sins are visited on our own heads when he declines to put it on paper "because he can't write." Ten to one, if he would only dictate his thoughts to a stenographer in the abandoned way he would word a business letter, we would find so much meat in the effort that we would gladly thresh it into shape and put the finishing literary "polish" on it without which it would not pass acceptance, even though it might add only a little to the intrinsic merit of the contribution.

Engineers Needed for Engineering Faculties

PERHAPS Dr. MANN'S report on engineering education, recently published by the associated societies which instituted the investigation, will indicate to those responsible for our technical curricula the tremendous gap between those offered by them and those required by prospective engineers. Practicing engineers, at least, are keenly aware of the deficiencies in their own education and of those whom they employ, since early in the investigation an inclusive questionnaire brought out the fact that in their judgment the factors most important for success were of the following importance and rank: Character, judgment, efficiency, understanding of men, knowledge and technique. Speaking generally, it is unquestionable that our schools are spending the bulk of their effort on giving their students a kaleidoscopic acquaintance with engineering science and technique to the substantial exclusion of the four other vastly more important qualifications.

Engineering education is broadly defined by Dr. MANN as a means by which production can be increased. In order to improve engineering education in this sense, three things are needed: First, better students; second, better curricula; and third and doubtless most important, better instructors. The 60 per cent mortality among the student body is adequate proof that the admission requirements are fundamentally wrong—many pupils are passed through high schools to rid them of an overwhelming burden of ignorance. Too many of these boys and girls then enter higher institutions on the strength of their poorly earned standing, or by an examination which tests their ability to "cram." Little thought and effort are given to determine whether the man has the willingness and capacity, the moral and physical stamina to go the hard road leading to real achievement. Those lacking physical stamina and technique may infallibly be eliminated by observing a probationary performance at some laborious shop-work, but tests for capacity, ability and character are still being sought. It will take better faculties to find them and, after finding them, to apply them.

Better curricula are urgently needed. The present style is congested beyond endurance, is too often an engineering potpie, with a half-baked foundation and indigestible crust. As Dr. MANN points out, a correct plan demands that the time schedule be determined by subject matter essential to the equipment of the engineer, instead of the present opposite practice. It will require broad-minded comprehension of the prospective needs of engineers to determine the subject matter essential to the equipment of all engineers—"the common core" of engineering education—and in addition the subject matter essential for a specialist. It will require better men in the faculties, men who have a knowledge of engineering as written in books, but more—a knowledge of engineering as written in works.

Individually, one can find instances where nearly all the problems of scientific curricula-making have been solved. The point yet to be established is coördination. Coördinate and motivate the industrial, laboratory, scientific and humanistic work into a whole, appealing to the student as really worth while! Train him in the ability to perceive relationships between the value of a thing and its cost, between the humdrum of

daily work-routine and the underlying laws of nature, the principles of science and the human factors! As so defined, one is tempted to make the assertion that proper coördination in engineering schools is absolutely non-existent. It will take instructors of the highest class to institute it.

It has been clearly pointed out that in order to profit from the result of the investigation on engineering education the faculties and governing boards must be in sympathy with the new point of view. Respect for departmental autonomy must in some manner be overcome, the inertia of faculty meetings must be reduced, coöperation and coördination between the various departments of instruction must be absolute. Here again rises the ever insistent demand for a broad-minded, capable, enthusiastic teaching body, throwing their whole soul into the training of young men—that best work man can do—without the incubus of seniority, precedent and poverty which now frightens off so many good men. The governing boards who hold the purse-strings can thus do yeoman service in hastening the dawn of a new and better education, by providing the funds for the most essential requisite—a better faculty.

Labor and Machinery In Iron Industry

ONE clear result of the war is a great increase in labor costs in the iron and steel industry. Unless the cost of machinery and equipment varies precisely as the cost of labor there is, obviously, a change in the relation between the two. When the relation stands at a certain level there is a point to which the introduction of "labor saving machinery," to use the common phrase, is advantageous, and beyond which it should not go. Every one recognizes, of course, that the "cost" of the machinery or whatever the equipment may be, when considered in this sense, is not the price that one pays for it, the cost in the abstract sense being a complex item involving first cost, current rate of interest on capital and whether or not a still better device may be developed within a short time.

There is good reason to believe that the changes that have been brought about by the war are such that the relation between the cost of labor and the cost of labor saving equipment has been altered to the disadvantage of employing labor and the advantage of employing machinery in the iron and steel industry. If so, there lies before the iron and steel industry an important period of improvement in the direction of displacing labor by machinery.

Incidentally, there is a contributing factor of no small importance, and that is that the tonnage capacity of the industry has grown so greatly that for a time there will be little disposition to increase capacity. As all going concerns are continually seeking to improve their position the talent they have will naturally be turned to the matter of improving the methods by which they turn out their present tonnage. In the past two or three years the case has been different. The object has been to increase tonnage the easiest way.

It might be argued that when there is a general advance in wage rates or a general advance in the cost of living, it affects everything more or less alike, hence the balance between the cost of employing a man and the cost of installing equipment to dispense with his services has not been altered. The increase in wage rates and cost of living, however, has not affected all alike. The iron and steel industry occupies a peculiar position. Its common labor has been recruited very largely from the ranks of the foreign born, in other words it has depended chiefly upon immigration. The American born do not gravitate greatly towards employment at blast furnaces, coke works and steel mills. As to immigration, the statistics are simple and easily remembered. It is recognized that the rate varies according to industrial activity. The year ended June 30, 1913, was a very active one at iron and steel plants. The following twelvemonth was one of sharply decreasing activity. The statistics of the two years are therefore quite indicative of normal before the war. They showed, for aliens and citizens, a net movement into the country averaging almost precisely 60,000 persons per month. For four years July 1, 1914, to June 30, 1918, this movement would have involved 2,880,000 persons. The actual was about 280,000. Thus a "deficit" accumulated of about 2,600,000. In July, 1918, there were very few arrivals and many departures, making a net loss in population of 33,193. The departures were probably chiefly of civilians going abroad for war work, it is true, but recent surveys in the industry have disclosed a widespread intention of workers to go abroad, to hunt up relatives with whom connection has been lost and to scrutinize industrial and living conditions in their native countries in the changed conditions they have been told the war is to produce. A Connellsville coke producer made a canvass of his workmen with the following result: 25 per cent. intended to stay on the job; 25 per cent. intended to make a trip abroad; 50 per cent. intended to go abroad and stay there. Of course the men will not all do what they say they intend to do, but something of that sort is undoubtedly going to occur, and there will not be much immigration to balance.

The position of the iron and steel industry is that its common labor is of one class, while the labor used in making the appliances it buys is largely of another class. The supply of the former is depleted more than the supply of the latter. The changes due to the war do not increase the cost of the machine as much as the cost of the man.

The average of all wages in the United States is likely to come down from the level existing at the close of the war, but common labor in the iron and steel industry is not likely to come down as much as the general average. There is even a possibility of the rate per hour increasing. Taking the standard rate at 42 cents an hour, the 12-hour man, with the "eight-hour basic day" is paid for 14 times this for 12 hours' work, so that the cost to the employer is 49 cents an hour. If the supply of men willing to work 10 or 12 hours a day becomes insufficient the answer is not to increase the hours of labor per man, but to make conditions such that additional men will be invited to seek the jobs. That may mean the introduction of the universal eight-hour shift, for as a rule the shift period must be a divisor of 24, and the wage rate may be higher than 42 cents an hour, or even 49 cents. It is certain that the ratio between iron and steel labor and labor in general has been increased, and that means that labor saving devices are worth more than formerly.

The Glory Of the Peanut

Time was when we considered it a measure of distinction or importance for a person or thing to occupy space in the Encyclopædia Brittanica; the more space, the greater the importance. The peanut is not mentioned in it. The Standard Dictionary gives an illustrated inch to it and announces that peanuts are beans on the ground that they are leguminosæ.

It is a lowly subject. On the railroad a peanut train consists of not more than two cars; as soon as the third is added the train becomes a "local." Those who engage in peanut politics are sometimes also referred to as small potatoes. Large potatoes have dignity, but no variety of peanuts achieves this rank either in literature or in colloquial speech. Nevertheless, these are days of democracy, and we demand that the world be made safe for it, so that the humble be made great. And just as some of our most cherished institutions such as monogamy, cooperative industry, the establishment of groups of states, paper-making and a thousand other manifestations of wisdom and ingenuity have been developed for us in insect, bird and other animal life of lower order than our own, so those things which we have scorned in days gone by are now achieving aristocracy in commerce and growing potentiality by leaps and bounds. Knick-knacks at five and ten cents each have built the tallest and handsomest office building in the world. The humble banana still retains its post on the street corner, now under Greek rather than Latin auspices, and since it has entered the portals of commerce as fruit, the ships to carry it have almost become the leaders of the tropic seas.

Holding its own along with the banana and still giving its name to the stands from which it is sold, the peanut abides, setting an example in literary culture which we have long been commending to the youth of our land: the more diligent study of Greek, with its vast wealth of literature, in the place of Latin. We offer the peanut in its shifting from Latin to Greek as a worthy exemplar to our authorities in education.

If sulphuric acid represents industrial advancement, why should not peanuts represent advancement in democracy? We mean true democracy, intelligent, cultured and constructive democracy, and not the anarchy of hate which we find among the Bolsheviki. They do not eat peanuts—and behold their madness and rage and destruction! The Germans developed their Kultur without the aid of peanuts, and they, too, have gone mad and the walls of their temple are falling in upon them and crushing them.

The peanut has always been striving to rise. We recall an estimable merchant, surely long since gathered to his fathers, who entered the Boston & Maine trains at Salem, Mass., many years ago, carrying a generous basket upon his arm and calling out, "Peanuts, peanuts; fresh roasted peanuts; five AND ten cents a bag." The ten-cent bags were triple the size of those sold for five cents. He was an honest merchant and gave good measure. It was only the buyer, however, or those seated near him who discovered the good man's desire to adjust his wares to the greatest measure of human consumption—and consequent betterment. We venture to suggest that this may have come from his association with peanuts. A nod of the head or a raised finger brought him to attention and service, and as he lifted the cover of his basket he displayed three separate compartments. Then he would inquire, "Low, medium or high roast?" and whoever could not be satisfied with such peanuts was a churl indeed. We preferred the high roast, but that was a matter of taste. The dealer, who was a busy man and indisposed to enter into idle conversation, favored the low roast, owing to the superior quality of the nut he offered for sale. Despite the Standard Dictionary, he never referred to his wares as beans. And he certainly knew peanuts.

Early in the '90s we recall occasional negotiations with a corporation which was popularly described as the Peanut Trust. It flourished chiefly in Virginia, but extended its operations also into North Carolina. We do not know whether it still exists, and we mention it merely to show the peanut ambition, which is not a thing to be scorned. Everything important in the United States was being organized into some kind of a trust. Early in the game, peanuts were on hand—and organized.

Now observe the rise of the humble goober following the research of the good Sabatier and the scramble for patents to profit by his discovery. Before the war this country produced about three and a half million bushels annually. In 1916 production rose to 40,000,000 bushels. In 1917 we devoted 3,277,000 acres to its cultivation; and its crops are bountiful. This year Texas alone has 3,000,000 acres growing peanuts with the prospect of a bumper yield.

It has robbed the boll weevil of its injury, for the vine is hardy against it, and the farmer who erstwhile raised cotton only to see his fields destroyed now raises peanuts and buys Liberty bonds. It has shaken the foundations of the Temple of Scarcity which the hog built for itself, because its excellent oil, hardened into fat by hydrogenation, supplies humanity's need for butter and lard wherever ships can carry it. Thus, also, it eases the burden of the overworked cow.

In addition to the peanuts that we grow and notwithstanding the difficulties and expense of shipping, our imports of peanut oil have increased sixfold since the war began and now reach over 8,000,000 gallons. If the Germans had offered Alsace and Lorraine back to France by way of honorable exchange, they could have received a generous portion of Northern Africa in return, and Northern Africa is a veritable paradise for peanuts. And the war might have been avoided because the Germans would have had their minds on something else. Then they would still be respected among men and every decent club and social organization would not be closed to them. Right here is where we see the subtle relation of peanuts to beans which is declared by the Standard Dictionary—a pretty good book, after all. The Germans didn't know beans in the large, true and catholic sense. They didn't know peanuts.

A new concept of measurement is added to human understanding. We have gaged the development of industry by statistics of sulphuric acid, of progress by steel and of civilization by soap. Now let us add the measure of democracy by peanuts.

Readers' Views and Comments

Measurement of Odors

To the Editor Chemical & Metallurgical Engineering

SIR:—The writers have read with much interest the letter of Mr. V. H. Gottschalk, which was published in the Nov. 15 issue of your esteemed journal, concerning our paper, "An Investigation of Stenches and Odors for Industrial Purposes," read at the Cleveland meeting of the American Chemical Society.

Evidently Mr. Gottschalk did not hear the paper read, and your reporter has been overly kind in crediting us with priority, which Mr. Gottschalk shows we have not deserved. No claims for priority in measurement of odors were made by us, although we were not aware of other work of the same nature; also we named our apparatus an "odorometer," and not "odormeter," as Mr. Gottschalk prefers. These discrepencies are due to reportorial error which will be evident as soon as the paper itself appears. We have noted since this question has arisen that the Standard Dictionary defines the word "odorimeter."

It is gratifying to see the interest which our paper on this subject creates, and we are indebted to Mr. Gottschalk for bringing to our attention previous work which has been published. We agree that the subject is one which deserves much further study. For the present the data which we are publishing are all that are needed by the Bureau of Mines to serve its purposes. It may be that other work will be done at some future time, but for the present, at least, it is ended. For this reason we will turn the matter over to other investigators, hoping that the work will receive further impetus.

S. H. KATZ,
V. C. ALLISON.

Pittsburgh, Pa.

Help for the Gold Producer

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with much interest your editorial of Nov. 1, "Help for the Gold Producer." I think the statement may safely be made that the currency situation is, next to the war, the most important problem that confronts the world. It is remarkable that the present state of unreality of our monetary standard is not more widely known and discussed than is the case. We are no longer on a gold basis, and, far worse, we are not even on any other definite, even if depreciated, basis. There is therefore nothing binding us to terra firma, and anything is possible with respect to inflation of prices. Already the stoppage of redemption of currency in gold and of international shipments of gold to adjust balances has resulted in expropriating from the widows and orphans et al. 20 per cent of their capital (American exchange is, or recently was, at about 20 per cent discount in countries still remaining on a real gold basis), but this is a small matter compared with what may happen yet.

As to the remedy, it is easy to say that all that is necessary is to get back to the gold basis. This, assuming it to be possible, would not remedy the rise in prices in so far as that is due to the depreciation in the value of gold—that is inevitable, although many observers believe the pendulum is about to swing the other way—but it would get us back to earth again.

While we have cut loose from the gold basis so far as making payments in gold and gold-demand currency is concerned, we refuse to pay the gold producer more for his product than formerly; that is, he gets a dollar currency for a dollar gold. What else is possible? To do otherwise would be a contradiction in terms so long as gold remains, even nominally, the basis of currency. You justly observe that to pay a bounty would be equivalent to raising the price of gold, but it may be added that there is no way the price of gold could be raised except only by paying a bounty. To pay $\$1 + x$ for $1 gold (23.22 grains) would be a bounty, pure, simple and undefiled.

There is an apparent attractiveness about anything that will "raise the price of gold" because we have always understood that a rise in the price of gold is another way of saying a fall in commodity prices.

One thing stands out, namely, that there is a certain grim humor in any criticism of the gold producers for not being able to suggest a feasible way out of a situation which, as present legislation stands, presents the same difficulties as does lifting oneself by one's boot-straps. In saying present legislation I mean that immediate relief would be given the producers if they were allowed to ship their gold to Spain, for instance, and, with the proceeds of its sale, buy American exchange.

ERNEST A. LE SUEUR.

Ottawa, Ont.

Analyzed Samples Wanted

To the Editor of Chemical & Metallurgical Engineering

SIR:—We are building up a collection of analyzed samples of raw materials, intermediate and finished products of our typical chemical industries, and expect to use these specimens as practical material in our courses in quantitative and technical analysis.

It has been our experience that the work in analytical chemistry is greatly strengthened by the use of such material, but at present the time of most instructors is too occupied to devote the time necessary to make the analyses required to check the results of the students. The laboratories of many of our chemical manufacturers make such analyses as a matter of routine, and it would be a very helpful method of coöperation if they could turn over to use and to other universities laboratory samples together with their analytical data on the same. You have advocated a closer coöperation between the manufacturers and the universities and it appears to me that here is a chance for a definite service involving little extra work on the part of the works' laboratory forces. Samples of one to two pounds are sufficient for a year's supply, and different samples of the same material are useful in diversifying the work of different students of the same class. We shall be glad to pay transportation charges. The standard samples issued by the Bureau of Standards are too expensive for general use and their range is too limited. R. E. OESPER.

Department of Chemistry,
University of Cincinnati,
Cincinnati, O.

Western Chemical and Metallurgical Field

Development of the Metallurgy of the Cripple Creek Ores

AMONG the many pleasant features of the recent Colorado meeting of the American Institute of Mining Engineers was a trip to Cripple Creek. The committee in charge followed the commendable plan of issuing a booklet describing briefly the notable features of the excursion, included in which was the following brief historical note on the metallurgy of sulpho-tellurides.

The first method adopted for local ore treatment, as has been the case in many other districts producing precious metal ores, was the stamp battery and plate amalgamation. During 1892 and 1893 ten stamp mills, with a total of 270 stamps, were erected. Although much of the gold from the surface ores occurred in a free state, it was soon proved that amalgamation was inefficient, due to the rusty nature of the gold. Concentrating tables and blankets were added to increase gold recovery, but even with these additions the extraction was low. Recovery became less and less as more of the unoxidized sulpho-tellurides were encountered, and stamp milling was soon entirely abandoned.

The first chlorination plant was built in the district by Edward Holden in 1893. Charles M. MacNeill was mill superintendent, and it was at this plant that D. C. Jackling secured his first position as assayer after walking into camp from Divide. From this time on various processes were tried for treating these ores, some fifteen mills in all being built. All of these were failures.

In 1895 a well-designed chlorination plant was built at Gillette under the supervision of J. Dawson Hawkins. This mill embodied all the improvements in chlorination known at that time. In 1897 the first cyanide mill (Brodie mill) was built at Mound City, under the direction of Philip Argall, following an earlier plant constructed in 1895 for the Metallic Extraction Co. at Florence. In 1896 and 1900 respectively Messrs. MacNeill, Penrose & Tutt built the Colorado & Philadelphia Chlorination Plant and the Standard Mill at Colorado City. Work was begun upon the Portland chlorination plant in 1901 and after operating as a chlorination plant for ten years following its opening in June, 1902, it was converted into a cyanide plant in 1912. In 1902 the Telluride Reduction Co. built a mill at Colorado City, employing bromine instead of chlorine; this was later converted into a cyanide plant, but finally failed in 1905. Philip Argall remodelled the plant, after it had been closed down for five years, into what is now known as the Golden Cycle Mill, and under the more recent management of A. L. Blomfield this has been developed into a highly efficient cyanide plant. Following the success of the chlorination mills built at Colorado City, the Union Chlorination Plant and the Dorcas Cyanide Mill were built at Florence.

From the first discoveries until recent years much of the ore produced in the Cripple Creek district has been shipped. After the first attempts at local milling, all of the higher-grade ore which was not smelted has been milled at plants located at Colorado City and Florence. Treatment of the ore outside the district continued until the building of low-grade mills by Stratton's Independence, the Portland and the Vindicator companies. The development of successful processes for the local treatment of low-grade ore which could not stand the expense of shipment has been an achievement of the first order. This development has rendered profitable many of the waste dumps and large bodies of low-grade ore left standing in the mines, thereby greatly prolonging the life of the camp. Through persistent research and able business management the low-grade complex ores of the district are as efficiently treated as simpler precious metal ores occurring elsewhere. During 1907-8 a number of small plants were built for the cyanide leaching of coarsely crushed surface oxidized ores. The plants met with a greater or less degree of success, but at best were short lived on account of the limited quantities of ore available suitable for this treatment.

In 1908 Philip Argall erected and began operating the Independence Mill, using a combination of concentration and cyanidation. The same year, after extensive investigation, the Portland company erected the Victor Mill, which was placed in operation five months later than the Independence Mill. Shortly after the flotation process had proved successful upon various base metal ores in the United States the Portland company began investigation of the treatment of Cripple Creek ores by this method. After giving the process a thorough trial on a large scale it was finally abandoned in favor of the cyanidation, as formerly practiced. In 1916 the Vindicator company (the first to operate a flotation on a large scale in the district) built its present mill, which has since been continuously and profitably operated.

The chlorination process as practiced upon Cripple Creek ores was the barrel process as developed in the Black Hills from the crude barrel process used in South Carolina. Many improvements were made, and eventually it was operated upon a far larger scale than ever had been attempted in the Black Hills. For years there was a struggle for supremacy between the chlorination and the cyanide processes, each having very strong advocates. Up until the conversion of the Golden Cycle Mill to a cyanide plant the bulk of the higher-grade ores not shipped to smelters were treated by chlorination. Following the successful demonstration of the process at this plant, the Portland chlorination plant was converted to cyanide and the chlorination mills at Colorado City and Florence were closed. The two metallurgical developments which gave cyanidation the advantage were fine grinding and the introduction of efficient methods of slime treatment. It is of interest in passing to note that practically all the old chlorination tailing has been re-treated by the cyanide process at a profit. At present the Colorado Springs cyanide plant of the Portland company is closed, and this company is doing all of its milling at the mine, while the Golden Cycle Mill is the only mill now operating outside the district.

The cyanide process, as at present developed for the treatment of the higher-grade Cripple Creek ores, consists of coarse crushing in rolls or comminutors, followed by roasting in Edwards, Pierce-Turrett or Holthoff furnaces. After roasting, fine grinding is accomplished in either tube or Chilean mills. The product is either treated by straight agitation and filtration or, after separation of sand and slime, the sand is leached and the slime treated by agitation and filtration.

Size vs. Recoveries in Ferromanganese Furnaces*

BY E. S. BARDWELL

Metallurgist, Anaconda Copper Mining Co.

RECENT observation of a number of electric furnaces varying considerably in size and transformer capacity, and all working under the same conditions, shows the small furnaces to be much more efficient in operation than the large furnaces.

The furnaces examined were all of the same type. The crucibles consisted of tanks varying in size from 7½ x 15 ft. x 4½ ft. deep, to 12 x 20 ft. x 9 ft. deep, with linings formed of carbon electrode butts. The smaller furnaces had transformer capacity rated at 1500 kva.; the largest furnace had a transformer rated at 3000 kva. All of the furnaces were operated on 3-phase, 60-cycle current, the three electrodes being in a straight line. The voltages varied from 65 volts in the smaller to 100 volts in the larger furnaces. The charges consisted of manganese ore, coal, iron turnings and limestone in proper proportions.

The small furnaces, operating at low voltage, were making good recoveries. The slag loss was low and the volatilization loss almost nil. The larger furnaces, operating at higher voltages, showed increased loss of manganese in the slag and greatly increased volatilization loss when working on the same charges as the smaller furnaces or on charges similarly calculated.

The exact reasons for this state of affairs are difficult to state; a number of factors probably contribute to the results obtained in the large furnaces. First as to the effect of the higher voltage on manganese content of the slags. Increasing the voltage of the furnaces apparently tends to promote irregular working. The current takes the path of least resistance; this means superheating in certain areas in the crucible and insufficiently high temperatures in adjoining areas. The partially reduced manganese in the cooler areas passes into the slag and escapes further reduction.

As to the effect of the higher voltages on volatilization losses, it is clear that the result of the excessively high local temperatures will be to augment volatilization. Furnaces operating at the higher voltages are also subject to the formation of accretions consisting of carbide and graphite, which tend to form with an excess of carbon. The formation of carbide robs the charge of a portion of its lime, rendering the slag composition very different from that calculated and desired. The electrodes are forced up, and volatilization is still further increased. The presence of carbide and graphite in the furnaces working at the higher voltages points to the existence of higher temperatures in these furnaces than in those operating at lower temperatures. The small furnaces rarely show signs of accretions, although both carbide and graphite are formed in them to a limited extent.

The advantages to be gained from having a large unit are obvious, although there is much to be said in favor of a number of smaller units. Assuming for the moment that a large furnace is desired, let us consider the voltage to be employed. It is evident that the large furnace possesses no advantage over the small furnace unless we can get proportional or more than proportional production from it. Output, of course, is dependent on power input. If we represent the current by I, the voltage between phases by E, and the reactance and impedance by X and Z respectively, we may write the following equations:

$$I = \frac{E}{\sqrt{3}Z}$$

$$Z = \sqrt{X^2 + R^2}$$

$$\text{Power input} = \sqrt{3}\,EIp$$

where p is the power factor.

Examining the first equation, we see that the current input may be increased either by increasing E or by decreasing Z. Experiments have shown that in any given furnace the reactance, X, is a constant for all except the very lightest loads; hence any decrease in the resistance, according to the second equation, will result in a decrease in the impedance and a corresponding increase in the current and power input.

The resistance of the charge may be decreased by substituting coke for a part or for all of the coal. If this is done, and if the voltage be kept reasonably low, it should be possible to obtain increased power input and steadier operating conditions than are obtainable on the higher-voltage furnace.

R. Korten[1] gives some interesting data regarding the melting of ferromanganese in the electric furnace, particularly in the Keller furnace. He states that melting without loss of manganese by volatilization is most certain if low voltage is employed, that the arc must be short, and the hearth offer as large a surface as possible. A uniform heating over a large surface and not an intense heating over a small surface should be sought.

While conditions are not exactly the same in electric furnaces for the smelting of manganese ores, my experience has been that better results are obtained where low voltages are employed and when the power input is properly proportioned to the size of furnace employed.

When treating Montana carbonate ore containing 36.8 per cent Mn and 6.79 per cent SiO_2, using coal as reducing agent and marble as flux, it has been found possible to keep the slag loss below 3 per cent of the manganese in the ore. The average slag analysis over a period of a week was as follows: Mn, 4.26; SiO_2, 34.37; Al_2O_3, 7.93; CaO, 44.83; MgO, 4.10; BaO, 0.88 per cent.

This result is extremely good when compared with the slag losses quoted by Mr. Keeney, which vary from 12 to 25 per cent. Results like the former are easy to get in small furnaces working at low voltages. I feel confident that we shall be able to duplicate them in large furnaces after sufficient study.

The greatest problem yet to solve is the reduction of the volatilization losses. We know that it is possible to keep this loss low in the small furnaces, and doubtless a more thorough understanding of furnace conditions will enable us to solve the problem in the case of the larger units.

Great Falls, Mont.

*Discussion of the paper of Robert M. Keeney, presented at the Colorado meeting, September, 1918.

[1] *Stahl und Eisen* (March 14, 1912) 32, 426.

Atlantic City Meeting of War Service Committees

A WAR Emergency and Reconstruction Conference will be held at Atlantic City, N. J., during the week of Dec. 2, under the auspices of the Chamber of Commerce of the United States. Mr. Horace Bowker, president of the Chemical Alliance, Inc., will be chairman of Major Group No. 7, on Chemicals.

Preliminary conferences of the representatives of the 380 war service committees will be organized Monday and held Tuesday. Double sessions at 10 a.m. and 2.30 p.m. will be held at the Million Dollar Pier on Wednesday and Friday. Wednesday evening the 35 minor groups will meet at 8 o'clock. Thursday, at 10 a.m. a general session will be held, and at 2.30 and 8 p.m. the 10 major groups will meet separately.

Major Groups

1. Food Products
2. Heat, Light and Power
3. Iron and Steel
4. Metals and Minerals Other Than Iron and Steel
5. Textiles
6. Wood and Wood Products
7. Chemicals
8. Leather
9. Earthen Products
10. Industrial Professions.

Questions to Be Discussed

1. What legal methods or means could be introduced in the craft to better stabilize prices, during the reconstruction period, affected by the following:
   a. Inventories on hand.
   b. Orders placed at war prices but not delivered.
   c. Labor costs and conditions.
   d. Increased taxes.
   e. Increased rates of interest.
   f. An estimated increased demand for non-war materials restricted during the war period.
   g. Will an increased production of your commodity increase the price of material or labor, or will a controlled redistribution of material and labor from war industries prevent such an increase?
   h. Discuss the practice of the sale of commodities at a price less than the cost of production. Its injury and disturbance on the industries and the ultimate consumer. What methods would you suggest to remedy this evil?
   i. If the Government sees fit to dispose of used materials and products in the open market, what effect will it have on your production and the sale of new goods? At home? Abroad?
   j. If it is not advisable for the Government to sell these goods on hand, either home or abroad, what shall it do with them?
   k. In this connection, what point of contact should business interests have with the governmental departments in the sale or disposition of these various commodities?

2. What is the estimated amount of labor, skilled and unskilled, male and female, required for the estimated 1919 production? What is to be the source of labor? How much must be moved? How much have you lost to war industries?

3. What is your financing problem during the reconstruction period? Do you recommend governmental aid? Is financial legislation needed? Should the Capital Issues Committee be continued during this period?

In this connection discuss and recommend what financial obligations, if any, the industries in your craft are under to the Government for moneys advanced for buildings, machinery or as loans or security for Government contracts. How are these to be liquidated or adjusted?

4. What method would you suggest for the cancellation of Government war orders with your craft that would create the least amount of hardship on the industries and permit a readjustment to normal commercial conditions?

5. On undelivered Government orders, what percentage of materials on hand, supplied either by the Government or purchased by you for these Government orders, can be utilized by your craft for commercial purposes during 1919? What disposition shall be made of those not usable?

6. Have you any suggestions to make as to the continuation of the War Industries Board or any of its divisions, or any other governmental departments during the period of reconstruction? Such board or departments to have the authority to control materials and regulate prices. If so, for what period?

7. What intelligent control of materials during the reconstruction period could the War Service Committee suggest which would prevent an over or under supply and avoid a demoralization of the market? Should this be controlled by the crafts or by a governmental agency?

8. What effect had the war program on your output? Was it increased or decreased? Will there be an increased demand during the reconstruction period? If materials are uncontrolled will prices go up or down?

9. What is the estimated tonnage or unit of production of your raw materials for 1918? For 1919? Estimated demand for foreign commerce for 1919?

10. What is the estimated demand for your finished product for 1919? How does this compare with the average demand per annum in weight or unit of production for a five-year period immediately prior to 1914?

11. Sources of your raw materials? Domestic or imported? If domestic, can railroad cross-hauling be eliminated by purchasing nearer your plants? Causes of cross-hauling? If imported, at what ports? Would other ports of entry be more advantageous? What ports and why?

12. The value of a uniform method of cost accounting for the individual manufacturer and the craft as a whole.

13. What suggestions of the Conservation Division made to your craft might, with financial profit to your craft, be continued during the readjustment period? Is it possible to maintain a conservation schedule after the war, without legislative authority?

14. What methods and practices, other than those your craft has already introduced, would simplify production, save materials, eliminate wasteful practices, reduce the number of styles, without destroying individual creativeness?

15. What propaganda is necessary to educate the retailer and consumer to accept these eliminations and simplifications, and what plans might be arranged for better functioning with committees of jobbers and retailers handling your commodities?

16. What percentage of the commodities represented by your War Service Committee was produced in the United States before the war and what percentage imported? What suggestion have you to make for increased production for domestic and foreign commerce?

17. What effect will foreign competition have on your business? Will it increase or decrease your production?

18. What is the underlying reason for the importation of foreign-made goods: Prices? Styles? Label? Quality? Design? Or excess demand over domestic supply?

19. What disposition should be made by the Government of her merchant marine?

20. What steps have you taken, or do you propose to take, for the entire craft to take advantage of the Webb-Pomerene Bill, which allows combination for foreign trade, or have you other plans? What do you suggest as the best means of financing foreign credits? What percentage of the foreign commerce heretofore controlled by Germany can your craft obtain and supply?

21. What study is necessary, and what suggestions have you to make, in order to determine what are the needs of our allied countries for rehabilitation, and how far can you supply both raw and finished materials until they have been rehabilitated?

22. Has your craft been solicited by, or are you soliciting, foreign countries to supply these materials for rehabilitation purposes? If solicited, does this come from the Allies, or from neutral or enemy countries?

23. Would you recommend the appointment of a committee of United States manufacturers to confer with similar committees from our allies, to learn of their plans for protecting industry during the reconstruction period? Also to obtain information regarding commodities and supplies needed by them and ourselves during this period?

24. When the demobilization of military forces takes place, how can these men best be returned to their former industrial pursuits, and how will it affect your labor situation?

In this connection, how closely should the Conference work with the governmental bodies in the study of demobilization plans?

25. What suggestions have you to make to encourage and stimulate public work, such as the building of roads, pavements, water and sewer extension, the construction of public buildings, school houses, etc.? What effect will it have on the labor market?

In this connection consider the building program in the United States and especially the utilization or destruction of new plants built for war purposes. Location of convalescent and reconstruction hospitals near industrial centers so that these men can be trained in the factories nearest to the hospitals without creating new vocational schools.

System of Radio-active Elements

By Ingo W. D. Hackh

TWENTY years ago saw the birth of a new science, the discovery of the radio-activity of thorium by G. C. Schmidt, Becquerel and Mme. Curie in 1898. Since that time we have witnessed a steady and gradual transformation in our conception of matter and new avenues have been opened for experimental investigation in many fields of physics, chemistry and biology. To-day we know of three series of radio-active substances, uranium, thorium and actinium series, which include about forty definite substances. Much work has been done to classify these forty radio-active substances and to establish their relationship to the periodic system of the chemical elements. Among the numerous publications on radio-activity and periodic system are those of van den Broek[1], Cameron[2], Meyer[3], Russell[4], Fajans[5], Soddy[6], Hönigschmidt[7], Venable[8] and others. Thus the connection between the chemical elements and the radio-active substances is fairly well established. Investigations on the high-frequency spectra or X-ray spectra of the elements furnished the so-called atomic numbers of the elements, beginning with H 1 and ending with Uranium 92, thus giving us a continuous series of 92 elements (of which 5 elements are not yet discovered) with increasing atomic weight. The elements of atomic numbers 81 to 92, that is, those elements of highest atomic weights, show radio-activity, and the conclusion is, therefore, that the atom of such an element has become unstable and disintegrates, that is, breaks up by forming "elements," resp. isotopes, of lower atomic weight.

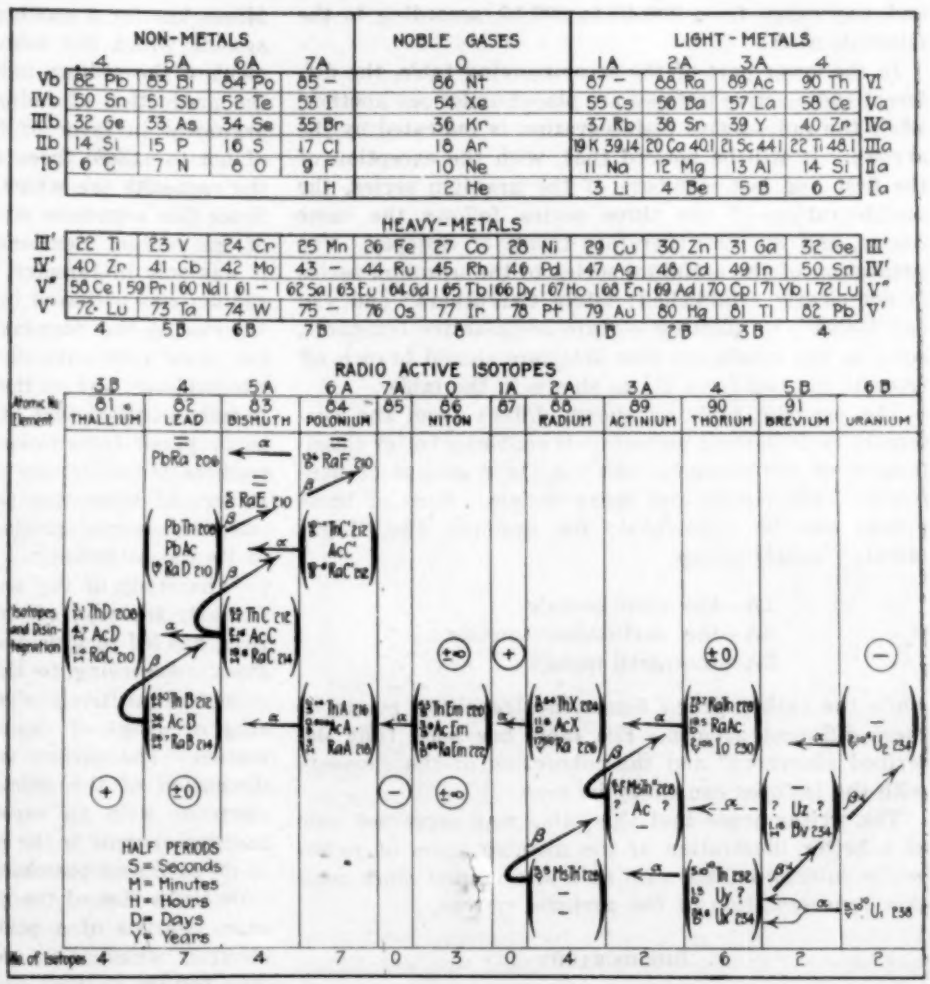
This integration or transmutation from an element of higher atomic weight to one of lower atomic weight takes place spontaneously at a definite period of time. This definite period is characteristic for each radio-active substance and is usually expressed in the "half-period," that is, the time required for the decay of one-half of any amount of a radio-active substance. This period is unchangeable and can at present not be affected by any physical and chemical means which our present knowledge offers. The disintegration takes place in two ways, according to two characteristic forms of transmutation, namely, the alpha-ray transmutation and the beta-ray transmutation.

The transmutation which is caused by the emission of alpha-rays lowers the atomic weight by 4 and the valency by 2 and makes the element more electro-positive. Alpha-rays are deviated by the magnetic and electric field and consist of positively charged nuclei of helium, traveling at a speed of about one-tenth the velocity of light and having a high power of ionization but small capacity of penetration, and are therefore quickly absorbed by the different media. They are of the type of the canal rays.

The transmutation caused by the emission of beta-rays makes the element more electro-negative, increases the valency by 1 and the atomic weight remains the same. Beta-rays are deviated by the magnetic field and consist of negatively charged electrons, having a speed of two-fifths to nine-tenths the velocity of light and possessing little power of ionization but high capacity of penetration. They are of the type of very fast cathode rays.

The gamma-rays are the secondary effect of the beta-rays, and can be compared with very hard X-rays, that is, they are produced by the impact of beta-rays (cathode rays) upon solids.

By the work of Hevesy[9], Fleck[10], Metzner[11], Fajans[12], Klemensiewicz[13], and others it has been found that the chemical nature of some radio-active disintegration products is similar to certain elements, and their experiments therefore confirm the evolution of the elements through the periodic table. Ordinary lead (atomic num-



THE HACKH PERIODIC SYSTEM WITH FLOW SHEET OF THE RADIO-ACTIVE ISOTONES

ber 82) would, for example, consist of the following "isotopes":

PbRa	At. weight 206.2	no radiation
PbTh	At. weight 208.2	no radiation
PbAc	At. weight ?	no radiation
RaD	At. weight 210.2	beta-radiation
ThB	At. weight 212.2	beta-radiation
AcB	At. weight ?	beta-radiation
RaB	At. weight 214.2	beta-radiation

and its atomic weight of 207.2 would be the average of the different isotopes and is dependent upon the period of these isotopes. In fact it has been shown by Mme. Curie[31], Richards and Lembert[32] and others that the atomic weight of lead from different sources differs, and may range from 206.40 to 207.15, according to the minerals used.

In the lower part of the accompanying table, the different radio-active isotopes are placed under one another, while the radio-active disintegration is indicated by the arrows. It will be noticed that, with the exception of the first and last members of the uranium series, the disintegration of the three series follows the same course, and we have therefore triads of isotopes. The connection of the actinium series to the uranium series is not clearly established; lately Carruthers[33] and van den Broek[34], by plotting certain radio-active constants, come to the conclusion that actinium should branch off from U, instead from U_2, as shown in the table.

The periodic table as shown differs from the customary table in some respects. It enables a better classification of the elements into the three groups of non-metals, light metals and heavy metals. Each of these groups can be subdivided; for example, the "Light Metals" include group

1A—the alkali metals
2A—the earth-alkali metals
3A—the earth metals

while the carbon-group forms the transition points of these different groups. The table has been fully described elsewhere[35] and the connection of the elements with the isotopes can easily be seen.

The writer hopes that this table may serve not only as a better illustration of the disintegration of radio-active substances, but also as a clearer and more compact representation of the periodic system.

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Radium and Radio-activity

AT THE first regular meeting of the New Jersey Chemical Society, held at the Technical School in Newark, N. J., Nov. 11, 1918, Dr. Charles H. Viol presented an address on "Radium and Radio-activity." In discussing the modern conceptions of radio-activity, radiant energy, electrons, isotopes, atomic disintegration and the transmutation of metals, Dr. Viol said:

"To date there has been produced in the United States a total of nearly two ounces of radium in the form of finished material of high purity, and of this total one and one-third ounces (37 grams) have been produced in the Radium Research Laboratory of the Standard Chemical Co. of Pittsburgh. The U. S. Bureau of Mines has for a number of years been waging a propaganda which has been quite harmful to the development of the radium industry, the object being to make the production of radium a government monopoly, the argument in favor of this being that there is a total of not to exceed three and a half ounces of radium in the carnotite ore which can be mined in this country. Since this argument was first advanced (in 1914) most of the radium mentioned above has been produced, as it was only in January, 1913, that the first high purity radium was prepared in the United States, in the laboratories of the Standard Chemical Co. This company has since systematically developed its extensive carnotite holdings, and on the basis of findings the statement is fully justified that at least 20 ounces of radium can be prepared from Colorado carnotite. This flatly contradicts the estimates made by the employees of the Bureau of Mines and certainly weakens the arguments on governmental production of radium, or limitation of its use to therapy.

"The study of the phenomena of radio-activity, particularly the rays of the radio-elements and of the X-rays, has led to a clearer insight into the nature of the atom. According to Rutherford, the atom consists of a central positively charged nucleus surrounded by a ring or rings of negative electrons in rapid orbital motion. The nucleus is small in comparison with the dimension of the atom, and is made up of negative electrons with an excess of positive electrons. The positive electron is the hydrogen nucleus, which because of its smallness possesses a great electro-magnetic mass, 1700 times that of the negative electron. The hydrogen atom consists of a positive electron and one negative electron, which is in obital motion about the neucleus. The helium nucleus consists of four hydrogen nuclei (positive electrons) and two negative electrons. The helium nucleus is remarkably stable, the experimental evidence indicating that the nucleus of the radio-element, when the atom transmutes, luses either a negative electron (beta ray) or a helium nucleus (alpha ray).

"In place of the old Periodic Law, we must now say that the chemical properties of the atoms are a periodic function of the nucleus charge. Isotopes are elements which have the same nucleus charge, but nuclei of different make up, consequently different atomic weights but identical chemical properties and spectra. Likewise two successive radio-elements which differ by a negative electron (mass electron = 1/1700 mass of hydrogen atom) will have sensibly the same atomic weights, but differ widely in chemical properties"

Conversion of a Brewery Into an Oil Refinery

A Description of the Conversion of a Standard Type Brewery Into An Edible Oil Refinery, Utilizing the Equipment With Some Alterations and Additions

FOR more than fifty years the George Hauck & Sons brewery at Kingston has been brewing lager beer. It had a capacity of 35,000 barrels a year and was of the standard type of small brewery. For a number of years past the Messrs. Hauck of the present generation and Mr. J. B. Kearney have been considering the unfavorable prospects of small breweries, and early in 1917 they called into consultation Mr. H. E. Brown, a chemical engineer of 115 Broadway, New York, who lives in Kingston. He made a preliminary investigation and his first report offered three plans for the conversion of the establishment into another manufacturing enterprise. These were to engage in either of the following industries:

1. Oils, margarines and lard compounds,
2. The manufacture of maltose,
3. Dairy products, condensed milk, ice creams, etc.

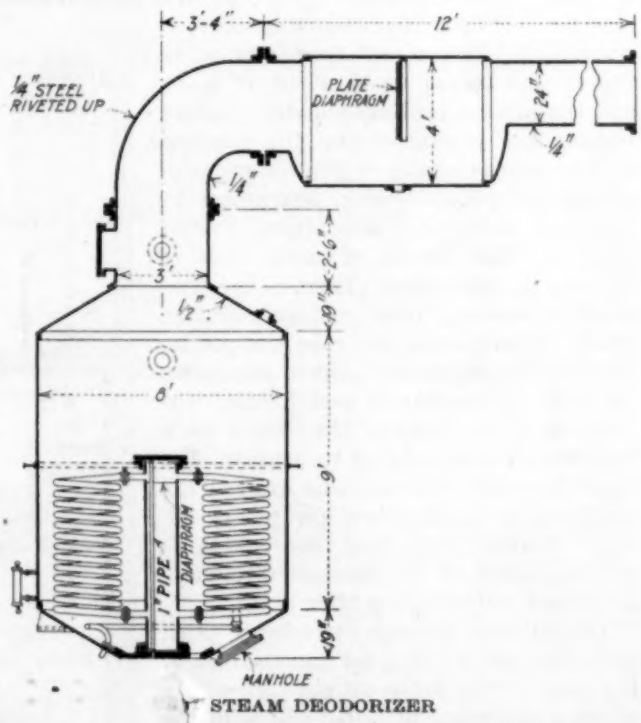
They chose the first, and in June, 1917, Mr. Brown began intensive study of the subject, which continued for two months. Three specific oils were considered, viz., cocoanut, peanut and cottonseed, and of these peanut oil was recommended. The detailed report gave complete costs of converting the brewery into an oil refining plant. After checking up the report with care independently, it was adopted in its entirety and in September, 1917, the word was given to go ahead. The Hauck Food Products Corporation was organized to succeed the George Hauck & Sons Brewing Co. and in October, 1917, they stopped brewing. Under ordinary conditions they would have been able to begin refining last January, but owing to delays in the delivery of machinery caused by unusual war conditions they were not able to put through the first lot of oil until August, 1918.

The time required for settling in the standard process of refining was a serious problem for their consultant, Mr. Brown. With the room and space available the capacity of the works would be limited, and after careful examination, tests and various consultations with the inventor, he resolved upon the process of refining invented and patented by Dr. Charles Baskerville, head of the department of chemistry of the College of the City of New York.

Rapid Separation of Foots

The striking feature of the Baskerville process is that instead of allowing the foots to settle and then siphoning off the clear oil, the oil is agitated with wood pulp or cotton linters and caustic solution, and after adding an electrolyte to coagulate the albuminous substances upon the fibers and to harden the soap in the foots, the whole is driven through a filter press, whence the hot oil proceeds immediately to the bleaching apparatus and from there to the deodorizer. Additional details will appear in sequence; it is desired now merely to emphasize the need of sufficient speed in the operation to give the works abundant capacity and at the same time to manufacture a high quality product. With this in view Mr. Brown designed a special deodorizer, which is shown in detail and which operates very rapidly. The capacity of the works when certain minor conveniences are installed will be approximately 30 tons of refined, bleached and deodorized oil per day.

Drawings are shown of two cross-sections of the installation which are self-explanatory to those familiar



STEAM DEODORIZER

with both brewing and oil refining. It should be recalled, however, that the main features of a typical beer brewery are as follows:

1. The corn cooker,
2. The mash tun, or tub,
3. The brew kettle,
4. The hop jack,
5. The cooler,
6. Fermenting cellar,
7. Rest cellar (or Ruh cellar),
8. Storage cellars.

These have been transformed or replaced as follows:

The corn cooker is replaced by a make-up tank for chemicals.

The mash tun becomes the refining kettle.

The brew kettle was sold and, being made of copper, it brought a good price. It was replaced by the deodorizer.

The hop jack was converted into a bleaching kettle. Fermenting and rest cellars are used for storage of crude and refined oils.

Utilization of Standard Brewery Equipment

All tanks, except of course those which are porcelain lined, were made available for oil by putting on a special coating made up under amended specifications of a patent designed for other purposes. The combinations of vegetable and bituminous waxes with which brewery tanks are lined will not do for oils. It was necessary also to replace copper piping owing to the action of the metal upon free fatty acids. Steel piping was substituted. The pumps required changes in the packing.

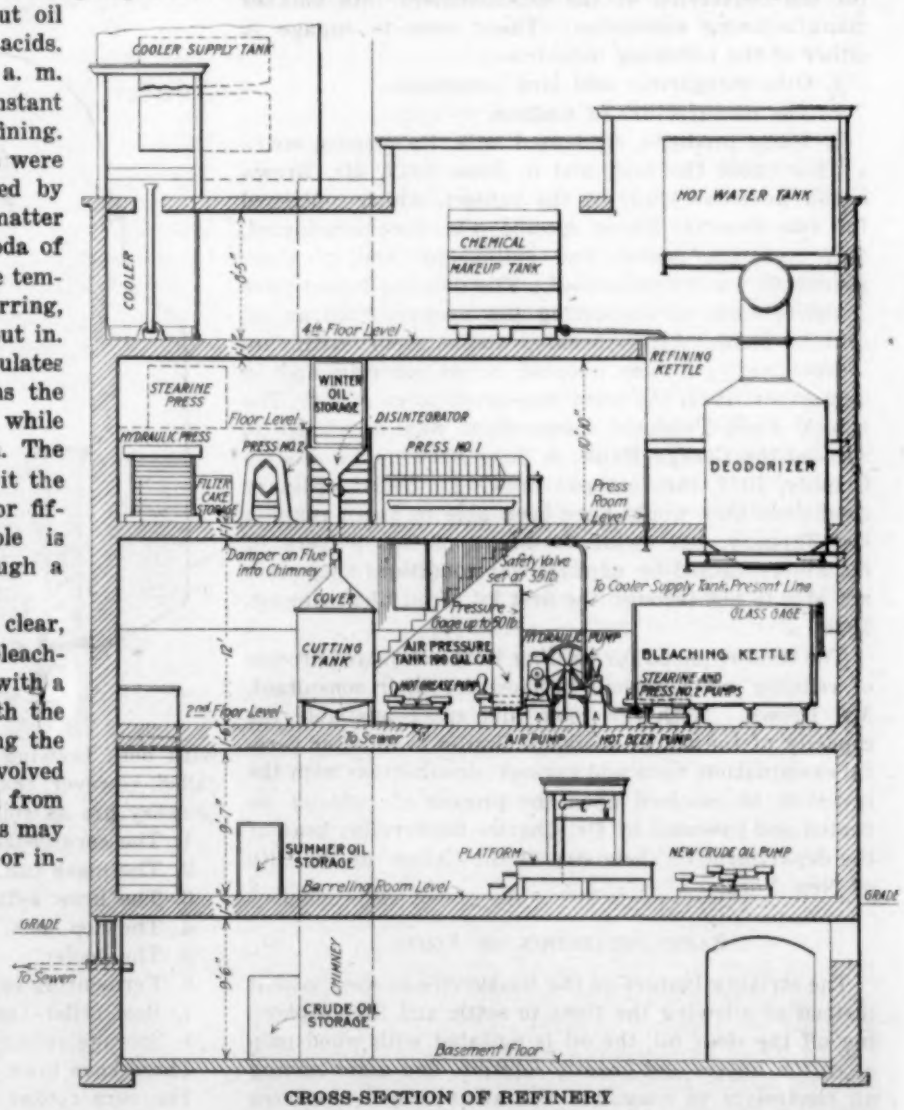
The old mash tub was converted into a refining kettle by adding revolving paddles to the agitators, eliminating the double bottom and providing a coil of steam pipe on the sides for heating. This has a maximum capacity of about thirteen tons of oil. If the crude oil is high in its free fatty acid content, it is desirable to reduce the charge somewhat. First there was pumped into this vessel 17,200 lb. Oriental peanut oil containing 1.28 per cent free fatty acids. Steam was turned on at about 10 a. m. and the process continued under constant temperature control during the refining. Eighty pounds of dry cotton linters were added, the amount being determined by the free acids and albuminous matter present. Then 298 lb. of caustic soda of 24.1 deg. B. was added. Then, as the temperature rose and under constant stirring, 230 lb. of anhydrous salt cake was put in. This is the electrolyte which coagulates the colloidal substances and hardens the foots upon the fibers of the linters while the clear oil holds them in suspension. The break is easily observed, and after it the agitation is slowed down for ten or fifteen minutes and then the whole is pumped under 60 lb. pressure through a Sweetland self-dumping filter press.

The oil runs through remarkably clear, and while still hot it is led into the bleaching kettle. This is the old hop jack with a stirring apparatus provided and with the requisite steam pipes for maintaining the temperature. No new principle is involved in the process, which carries the oil from simple brightening to water white, as may be desired. Fuller's earth, charcoal or infusorial earth may be employed, according to the results that are called for. When simple brightening is the object, infusorial earth is used. After bleaching the oil is run through a smaller Johnson filter press to remove the medium.

While still hot it is pumped to the deodorizer, the design of which is shown. It contains six coils of steam pipe (of which two are shown in the section), 24 inches in diameter. In the center of one of the coils is a propeller, the revolutions of which keep the oil in constant circulation. A vacuum of 26 to 27½ inches is maintained above the oil and steam is let into the coils at first at boiler pressure. Then to increase the temperature superheated steam is introduced into the coils and at the same time superheated steam is let into a perforated pipe at the bottom of the apparatus. This passes through the oil, increases the agitation and carries off all the constituents which impart rank odor and taste. The finish is determined by test samples. The oil is now at a pretty high temperature and would oxidize on contact with the air; therefore in the place of the superheated steam, cold water is introduced into the coils until the desired temperature is reached. The oil is then run into storage tanks and is ready for market.

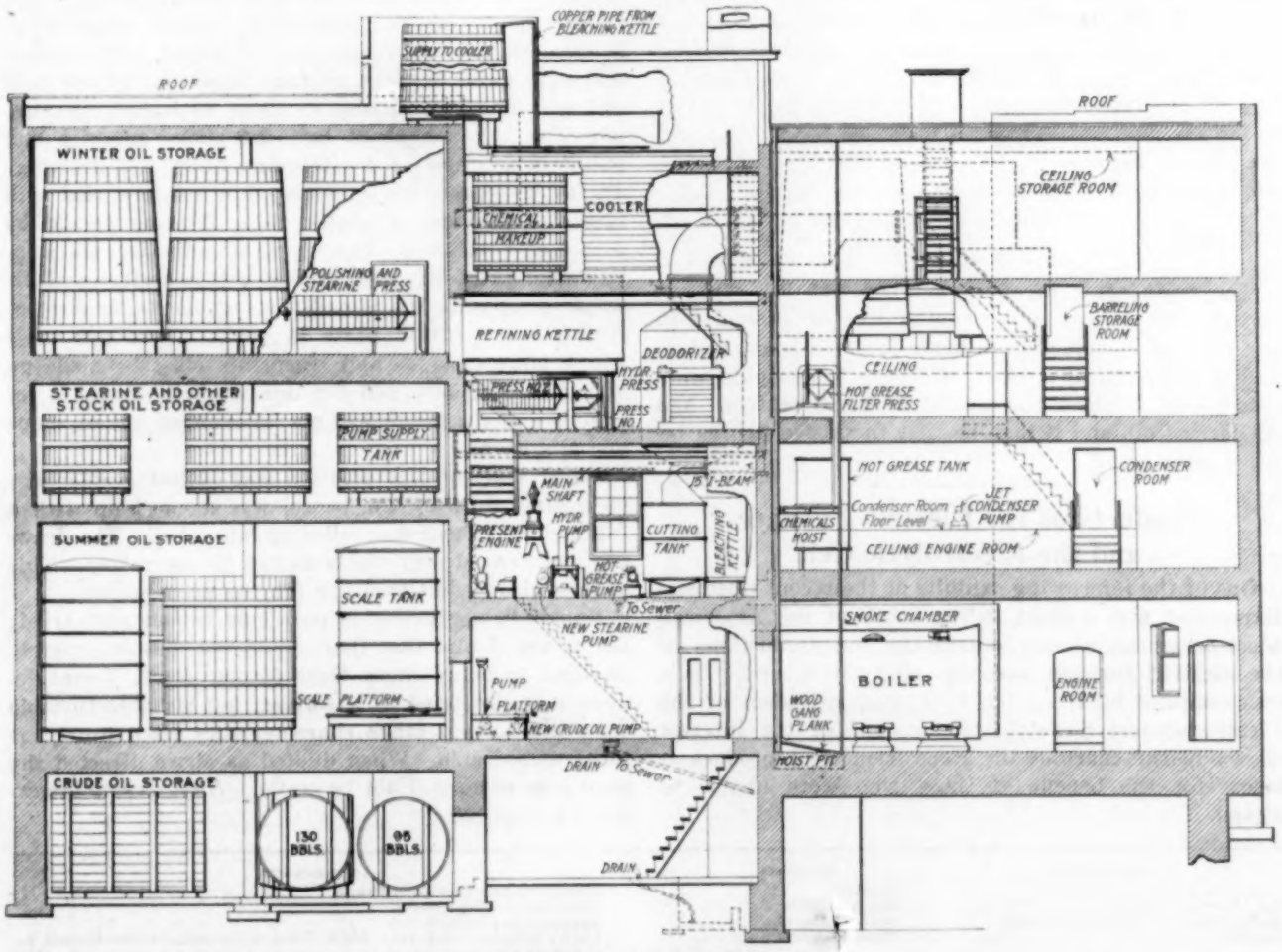
The Separation of the Foots in the Filter Press

The dehydrated causticized oil is filtered in a dumping Sweetland press, thereby separating the foots from the refined oil. The cake is carried to a screw press, where 100 lb. per sq.in. force is applied to remove the oil content. The cake, which is now made up chiefly of linters, soap and albuminous matter, is placed in a lead-lined kettle, where it is cut, and the free fatty acids liberated. The whole mass is then agitated and treated with hot water and steam and in this condition



CROSS-SECTION OF REFINERY

sent to a wood-frame filter press operating on 30 to 40 lb. pressure and the linters separated from the free fatty acids, liquid albuminous matter and slight excess of oils, the cake being thoroughly steamed out, so that only traces of oil and free fatty acids remain with the linters. The mixture of water, free fatty acids and oils is then led to a separating tank, the water separated by gravity, thus leaving the foots in condition to be barrelled, ready for sale to the soap manufacturers. The amount of linters required in refining is so slight that this process is put through only occasionally. The pressed cake is stored until enough for a run is on hand.



CROSS-SECTION OF REFINERY

This completes the process, but a few notes may be added. Anhydrous salt cake (or Glauber's salt) is used for the electrolyte in the refining process because it is economically available in Kingston. In another plant now in process of installation by Mr. Brown, sodium carbonate is used in place of it, and instead of cotton linters as the mechanical basis for coagulation wood pulp is employed and the foots are to be converted into soap powder. The pulp becomes gelatinized during the process.

Installation is under way to make winter oil in which the refined, bleached and deodorized product is to be piped to a cold storage room and refrigerated to zero deg. C. for a proper time to precipitate the stearines, after which the oils are filtered again, thus producing an oil which remains clear at zero deg. C. One-quarter to one-half of one per cent of the weight of the oil is, roughly, the amount of cotton linters needed in the Baskerville process, but this, as has been already noted, must be determined beforehand according to the content of free acid and albuminous matter.

Although it is easier to work with dilute caustic soda, this is not feasible with the Baskerville process because an excess of water tends to produce an emulsion with the soap formed, which is the very thing that must be avoided. The very lively agitation during the refining process and proper care in adding the caustic soda prevent irregularity in saponification and effectively neutralize the free acids. This point is important.

The company has had difficulty in getting satisfactory filter cloth owing to war conditions. It is necessary to clean the cloths carefully after each pressing inasmuch as the linters make a filter of themselves and unless the cloths are well laundered they clog up. It is planned to substitute Monell metal screens for this purpose.

In regard to margarine, for which among other purposes the oil is available, the laws provide a curious and needless expense. The normal color of good peanut oil is a beautiful yellow, slightly on the greenish shade, like olive oil. But if it is to go into margarine it must be bleached water white and the product, if it is to be yellow, must be colored by the final purchaser. It is a little point made by the farmers that a butter substitute must not look like butter when it is sold save against prohibitory tax. So the farmer colors his butter yellow and the housewife colors her margarine ditto

and we all know that there isn't butter enough to go around.

The plant is half a mile from the railway station and about an equal distance from the docks. To meet this situation a 5-ton tank truck has been provided which loads and delivers that quantity of crude oil in forty-five minutes.

The process requires constant chemical control. Rule of thumb methods will not do.

Figures on Refining Losses

In conclusion are given some weighings recorded in connection with the 17,200 lb. of oil which was refined in 32 minutes and filtered in 27 minutes:

There was added to the oil in the refining kettle	
80 lb. of linters	
298 lb. caustic soda. (24.1 deg. B. 18.68 per cent NaOH)	
230 lb. anhydrous salt cake	
or a total of	608 lb.
Wt. of re-pressed cake foots	909 lb.
Wt. of additions	608 lb.
Refining loss	301 lb. = $\frac{301 \times 100}{17,200}$ = 1.75 per cent
	Loss of oil = 1.75 — 1.28 = 0.47 per cent

The foots after pressing weighed 411 lb. This is remarkable, indicating a refining loss of around 1.75 per cent when deduction is made for free acids, linters and the theoretical amount of soda. No weights were determined to check the weight of the brightened and deodorized oil, and it may be that the above figures involve some error.

Products of the Electric Furnace and the Electrolytic Cell

One of the interesting exhibits at the recent Chemical Exposition was a chart in the booth of the American Electrochemical Society portraying the productions of the electric furnace and the electrolytic cell. This was compiled by Dr. C. G. Fink, past president of the Electrochemical Society. On account of the interest shown in the chart at the Exposition we reproduce it below for the benefit of those who were unable to attend.

Raw Materials	Products	Applications
Anthracite Coal	Graphite	Electrodes, Lubricants and Paints.
Sand, Sawdust and Coke	Silicon Carbide	Abrasives and Refractories.
Bauxite (Natural Aluminium Oxide)	Artificial Emery	Abrasives and Refractories.
Bauxite	Aluminium Metal	Cable, Aeroplane and Auto Alloys, Kitchen Utensils, Aluminothermic Reactions, Deoxidising Steel, Camp Utensils, Ammonial (explosive), Speaking Tubes on Naval Vessels, Acid Containers.
Sand and Coke	Silicon	Silicon—Steel, Hydrogen for Balloons, Resistance Units, Silicodes, Silicon Tetrachloride.
Quartz Rock	Fused Quartz	Silica Tubes, Heat Resisting Materials.
Coke and Sulphur	Carbon Bisulphide	Solvent, Insecticide, Carbon Tetrachloride Viscos.
Phosphate Rock, Coke and Sand	Phosphorus	Matches, Phosphorous Compounds, Phosphor Bronze, Smoke Screens.
Lime and Coke	Calcium Carbide	Acetylene for Welding, Cutting and Lighting, Aceton, Acetic Acid, Aeroplane Dope.
Calcium Carbide, Nitrogen of the Air	Calcium Cyanamide	Fertilizer, Ammonia, Cyanides.
Tin Dross	Refined Tin	Tin Plate Industry, Bronzes.
Iron Ore	Pig Iron	Steel Industry.
Iron, Silica Rock, Coke	Ferrosilicon	Making Steel, Making Hydrogen.
Manganese Ore and Coke	Ferromanganese	Steel, Permanganates.
Chrome Ore	Ferrochrome	Special and High Speed Steels, Armor Plate, Projectiles.
Tungsten Ore	Ferrotungsten	Special and High Speed Steels.
Molybdenum Ore	Ferromolybdenum	Special Steels.
Titanium Ore	Ferrotitanium	Scavenger in Steel Making.
Zinc Ore	Pure Zinc Metal	Brass Industry.
Water	Hydrogen and Oxygen	Balloons, Oxywelding, Oxycutting.
Water, Salt	Caustic (NaOH)	Soap, Paper Industry, Making Explosives.
Water, Salt	Chlorine Gas	Bleaching, Explosives, Chlor-benzol, Gas Warfare, Mustard Gas, Phosgene, Chlorpicrine, Silicon Tetrachloride, Water Purification, Sanitation, Surgery (Dakin solution), Detinning, Artificial Plastics (Halowax), Hydrochloric Acid, Aluminium, Chloride for Oil Refining.
Water, Salt	Hypochlorite	Disinfectants.
Water, Salt	Sodium Metal	Peroxides, Cyanides, Bleaching, Mining.
Water, Salt	Hydrogen	Ballooning, Hydrogenate Fat (for cooking).
Magnesium Chloride or Magnesia	Magnesium Metal	Flashlight Powders, Light, Wright Alloys, Tracer Bullets and Flares.
Air	Nitric Acid	Explosives, Fertilizers.
Air	Ozone	Sterilization of Water.
Crude Copper	Pure Copper	Electrical Industry.
Pig Iron	Pure or "Swedish Iron"	Tubes and Special Steels.
Potassium Chloride	Potassium Chlorate	Primers, Matches, Dyeing.
Chromium	Sodium Bichromate	Dyeing.

Adhesive Waterproof Drawings and Tracings Without Crimping

By John S. Carpenter

WATERPROOFING of drawings and tracings so that they can be used in wet places is done by the use of a preparation composed of gum rubber and benzol.

Benzol dissolves rubber, and the compound thus formed will keep in any climate and under any conditions. As benzol is inflammable, it should be kept in a safe place in a covered jar. If the proper precautions are taken in its use, however, it is not dangerous.

In a quart jar put a piece of rubber about 4 in. square; to this add a half pint of benzol. The rubber will soon swell to three or four times its former bulk and will be ready for use in about 24 hours. To prepare for use take about half the above quantity and put it in another jar for thinning down. If drawings are to be coated use a rather thin solution that will spread well under a brush. The drawing should be coated on both sides. For use as an adhesive, the solution should be fairly stiff, so that if it is desirable afterward to separate the joined parts it can be done more readily than if thin paste is used. There are cases where large tracings and blueprints must be made up of smaller sections, and for this work the paste is invaluable, as the joints will not be crimped out of shape and alignment.

When some of this solution was spilled accidentally on a dirty drawing the benzol was mopped up with a rag and the rubber was rolled up into a ball. The drawing was cleaned very nicely during the operation. This suggested an additional use for the preparation.

Rubber bands instead of pure gum rubber were tried; but it was found that they would not dissolve, merely swelling to many times their former size. Formaldehyde was also tried as a solvent, but its objectionable odor and certain other characteristics have proved it to be undesirable. When diluted as above directed the pure gum paste will not be costly.—*Engineering News-Record*, Sept. 26.

Nitrogen Fixation Furnaces—II*

A Discussion of the Operating Technology of Arc Furnaces—Power Factor, Reactance, Air Supply, Increase of Pressure and Oxygen Concentration, Absorption of the Products and the Theory of the Reaction Between Oxygen and Nitrogen

By E. KILBURN SCOTT

THE expanding arcs of electric furnaces give a capacity or leading-current effect, and but for the large amount of reactance used to steady the furnace the power factor would be high. With diverging electrodes the arc at the commencement of each half period is small and gradually lengthens until it breaks, so the resistance may be represented by the rising line of Fig. 14. The low resistance causes the current at the beginning to be large, as indicated by the exaggerated current wave of Fig. 14. When compared with the voltage wave the effect is as if the current were leading, and in practice such is found to be the case. Diverging electrodes also act, with the air between, as a sort of condenser, and a feeble spark is sometimes noticed between the tips of the electrodes where they approach nearest together, which is due to the condenser action.

In the Birkeland-Eyde furnace the interaction of the magnetic field with the alternating current passing between the electrodes is also said to cause the current to lead. The power-factor is certainly higher than with the Schönherr furnace, and this may be due to the latter having a steel tube around the long arc, which gives an inductive effect such as would be the case if armor were placed around a single conductor carrying alternating current. Dr. C. P. Steinmetz considers that the "standing arc" of the Schönherr furnace acts in the opposite way to the expanding arcs of other furnaces, and the resistance of the arc being high at the start causes a current wave distortion which is equivalent to a lagging current.

Reactances

Small choke coils or reactances can be made with adjustable iron cores; also the regulation of series arc lighting can be effected by an apparatus having movable coils. It would be useful to have such readily adjustable reactances for electric furnace working, but as the power required for furnaces is very considerable, it is difficult to keep a movable core or movable coils steady enough, and probably also the core would become too hot.

It is inconvenient to alter the amount of reactance by changing number of turns of a choke coil, because the one connected to the switch contacts would act for the time being as a short circuited secondary, and the large currents which would be induced are difficult to switch. One way to alter reactance while the furnace is running is to change the connections of the coils from series to parallel; another is to have a number of reactances in parallel and change the number of them in circuit. This latter method is employed for the 4000-kw. Birkeland-Eyde furnaces. When starting such a furnace that has been relined, the method is to switch in only one of three reactors, which allows about 1400 kw. to pass. As the lining dries out the other reactors are switched in one after the other until the furnace receives the full 4000 kw.

During early experiments with a K. S. 3-phase furnace it was considered desirable to interpose transformers of one-to-one ratio between the furnace and the alternating current supply, so that in case any abnormal condition occurred a magnetic link between the two circuits would act as a protection to the alternator. By suitably adjusting the sectional area of the core and the disposition of the coils, the magnetic leakage varied with the current and regulation was very good. The writer understands that reactors on this principle are now used in Norway, the core being built on the lines of a Berry transformer, with groups of plates radiating from a central core around which are coils of circular shape. The magnetic forces are thus balanced, and the coils always retain their position.

Although many reactors are built with iron cores, there is a tendency to dispense with the iron because reactors without it are more accessible, and as the conductors are of bare copper supported in cement concrete they are fireproof. They have to be placed away from structural steelwork. One form of coil known as a "toroid" has the advantage of giving the greatest amount of self-induction with least amount of electrical resistance. It consists of bare copper strip wound concentrically into a flat coil with the turns spaced well apart and set in cement concrete.

A neat form of reactor made by the General Electric Co. is shown in Fig. 15. The conductor is bare copper wire, wound in slightly conical layers, the turns of the first layer progressing from outside to inside and of the second layer from the inside to outside, and so on. The layers converge where the voltage is a minimum, the clearance between turns being about an inch (2.5 cm.) for 6600 volts. The concrete is freed from metallic particles and cured in the presence of high pressure steam, and the whole is supported from the ground by porcelain post insulators.

Air Supply

The yield of a furnace depends to some extent on the condition of the air blown through the arc, for if charged with dust particles, moisture or oil, or the acid vapors of large industrial centers, results are not so good as when the air is clean and dry. While working an experimental plant in Manchester, England, it was found that the yields on moist days were lower than

*Completion of the paper read at the thirty-fourth general meeting of the American Electrochemical Society, held at Atlantic City, N. J., Sept. 30, 1918.

when the atmosphere was comparatively dry. The air should have an easy flow from the blower to the furnace, that is to say, pipes should be as short and straight as possible, and the branches of similar length, so that each furnace may receive the same pressure.

Expanding nozzles have been recommended for delivering air to the flame, but the writer has found them liable to set up throbbings in the air flow. To get even flow, the pressure at discharge has to be about half the initial pressure, and this condition is not easy to meet with air at low pressure and high velocity, because the expanding portion has to be excessively long. Air compressors of the reciprocating type are not suitable for the supply of air to nitrogen fixation furnaces, because the air must flow in an absolutely steady stream and be free from oil, etc., also such compressors are only efficient for pressures above 15 lb. per sq.in. (1 atmosphere). Pressure blowers such as the Root type may be used, but as they also work by pocketing air and carrying it over to the delivery side, the pressure is somewhat uneven. They work efficiently with pressures up to about 8 lb. per sq.in. (0.5 atmosphere). Fans give steady flow, but are inefficient because they do not use the velocity energy of the air at the impeller exit. Also they are only efficient for pressures below 1 lb. or so per sq.in. (0.07 atmosphere).

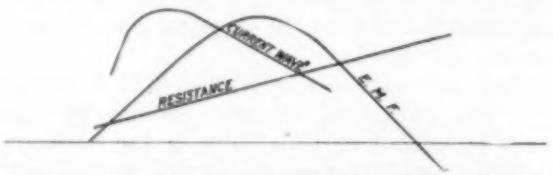


FIG. 14. SHOWING THE EFFECT OF ARCS WHICH INCREASE IN RESISTANCE

Centrifugal compressors are a good type, because they are efficient and deliver a steady stream of air at pressures necessary for the furnaces. They resemble a centrifugal pump in having a rapidly rotating impeller surrounded by a stationary set of discharge vanes supported by the casing. For pressures up to 4 lb. per sq.in. (0.25 atmosphere) one impeller is used, and higher pressures are obtained by merely multiplying the number of impellers. The speeds are suitable for coupling them direct to either steam turbines or 60-cycle induction motors. With 25 cycles the motor speeds are lower and gearing has to be used.

Power for Centrifugal Compressor

The amount of power required to blow the air through the furnaces depends on the pressure, but it is usually less than 3 per cent of the energy which is supplied to the furnaces. The theoretical horsepower required to compress adiabatically 100 cubic feet of air (3 cu.m.) at atmospheric pressure is given by the curve Fig. 16. It will be noted that it is not a straight line. Assuming that a 10,000-kw. factory requires 700,000 cubic feet (20,000 cu.m.) of air per hour, or 11,660 cu.ft. (330 cu.m.) per minute, then for a pressure of 5 lb. per sq.in. (0.33 atmosphere) the power is

$$\frac{11{,}660 \times 2}{100} = 232 \text{ theoretical horsepower.}$$

A centrifugal compressor for this duty would have two stages, and run at about 3450 rev. per minute with an efficiency of 70 per cent, so about 400 shaft horsepower would be required. Allowing for efficiency of the motor, about 200 kw. would be supplied, and it will be seen that even at 5 lb. pressure the energy taken by the centrifugal blower is only about 2 per cent of the energy put into the furnaces.

The high speed of the centrifugal compressor makes it suitable for being driven by a steam turbine, and if the turbine is supplied with steam at 120 lb. per sq.in. (8 atmospheres) the consumption of steam may be assumed at about $200 \times 18 = 3{,}600$ lb. (1,630 kg.) per hour.

Preheater

Preheating the air before it enters the furnace is advantageous because it raises the average temperature of the arc, and electrical operation is improved owing to the air being already in an ionized condition. With preheat the velocity of the air can also be lower than when the air is cold. For a given production of nitric acid the electric energy used is rather lower with highly preheated air.

The Schönherr furnace has a preheater combined with it, which takes the form of several annular tubes of steel around a central reaction chamber, and the entering cold air and the exit gases pass through these tubes in counter-current directions. As the gases leave the reaction chambers at over 1000 deg. C. it is possible to give a very high preheat to the entering air. At Saaheim, in Norway, there are 96 of these furnaces of 1000 kw., each one with its own preheater. The Birkeland-Eyde furnace has also a preheater, because the air passes into the reaction chamber through a large number of small holes in the refractory chammotte lining. As the electric arc keeps this lining at red heat, the entering air is preheated somewhat before it strikes the arc. This lining constitutes one of the objections to this furnace, because it is expensive to build and takes several days to dry out.

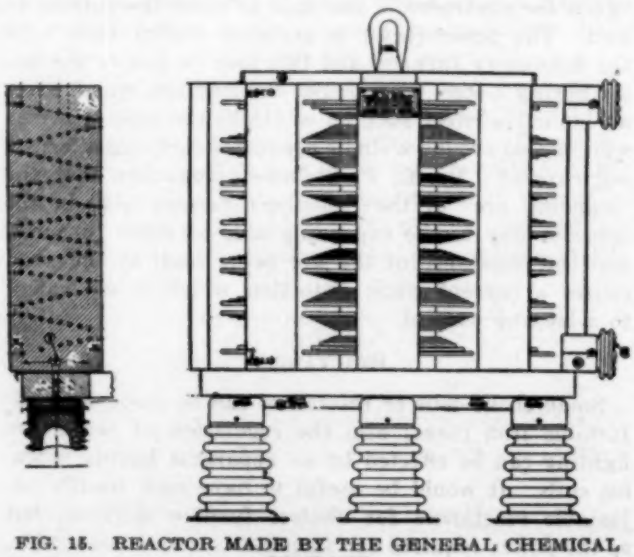


FIG. 15. REACTOR MADE BY THE GENERAL CHEMICAL COMPANY

In several ways it is an advantage to employ a separate preheater, to serve a number of furnaces, one reason being that it can be designed efficiently to give the heat exchange. Also, hot air is always available in starting a new furnace, for when a furnace has its own preheater some time must obviously elapse before heat is available to warm up the incoming air.

It is usual to employ boilers to utilize the bulk of the heat from the furnace gases in raising steam. If the gases leave the boiler at 250 deg. C. and a further 150 deg. C. is absorbed in the preheater, then the preheater may be made of steel. At the same time it is advisable to have it in several units so as to take care of the expansion due to difference in temperature at the two ends. Thin steel tubes may be used, and the air should pass around them.

Effect of Adding Oxygen

By weight air consists of 23 per cent oxygen and 77 per cent nitrogen; or by volume 20.7 per cent oxygen and 79.3 per cent nitrogen. One pound at 62 deg. F. and barometer at 30 inches occupies 13 cu.ft. (1 kg. = 0.81 cu.m.). One pound of oxygen at 62 deg. F. occupies 12 cu.ft. (1 kg. = 0.75 cu.m.), and is contained in 56 cu.ft. of air (3.5 cu.m.).

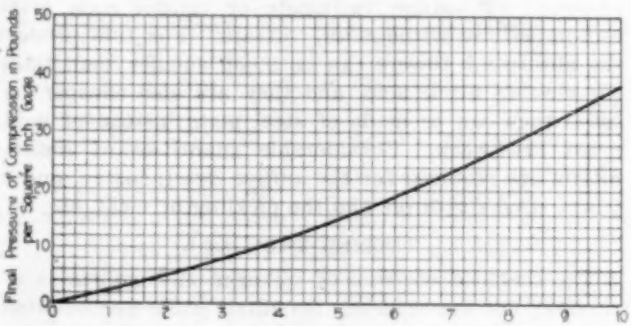


FIG. 16. CURVE GIVING THEORETICAL HORSEPOWER TO COMPRESS AIR

It is an advantage to add oxygen to the air passing through the furnace, because the concentration of nitric oxide is a maximum when the product of oxygen and nitrogen is also a maximum. It can be shown that it is directly proportional to the square root of the product; thus the equation for air is: $0.21 \times 0.79 = 0.16$. And for equal parts of oxygen and nitrogen $0.5 \times 0.5 = 0.25$. The increased yield is therefore 20 per cent, as shown by the ratio:

$$\sqrt{16} : \sqrt{25} :: 100 : 120$$

Commercially it is only possible to add oxygen when the process is worked in a closed cycle, the amount required continuously being then only that which the nitric oxide takes up.

If we assume that a factory utilizing 10,000 kw. requires 700,000 cu.ft. of air (20,000 cu.m.) per hour then 21 per cent of this, equal to 145,000 cu.ft. (4140 cu.m.), represents the oxygen. After passing through the furnace the air contained about 1.5 per cent nitric oxide of which about half is oxygen. The oxygen does not have to be pure, and if the oxygen-producing apparatus makes a mixture of 75 per cent oxygen and 25 per cent nitrogen, then about 1 per cent of the 145,000 cu.ft. (4,140 cu.m.), or, say, 1450 cu.ft. (41.4 cu.m.), per hour will have to be added continuously.

Addition of oxygen (to the air) is equivalent to increasing its pressure, for in air it occupies only one-fifth of the volume, whereas when it is equal with the nitrogen it occupies half of the volume. The effect is, therefore, the same as increasing pressure 2½ times, because much more oxygen is passed through the furnace. This is equivalent to $14.7 \times 2.5 = 35$ lb. per sq.in. (2.4 atmospheres), yet at the same time the furnace walls do not have to withstand any extra pressure.

Pure oxygen and hydrogen can be made by electrolysis, but it requires a great deal of direct current. Also pure oxygen and nitrogen can be made from liquid air, but this requires much machinery and power. In some cases, however, oxygen made by these methods is a by-product of other manufacturing processes. Thus oxygen is a by-product of plants making hydrogen for fat hardening; also it is a by-product in the manufacture of calcium cyanamide, because that process only requires pure nitrogen. Where it can be obtained such by-product oxygen should be cheap.

Hitherto the manufacture of oxygen has been practically a monopoly and in consequence prices have been kept at a high level and little improvement made in methods of manufacture. In the near future there is every possibility of oxygen being produced in larger quantity and much cheaper. The Jefferies-Norton process for air separation makes use of liquefication and distillation, but it has new features in the method of heat exchange and in the still. In general appearance the apparatus is very similar to the Claude system, but an essential difference is that the major part of the nitrogen is not expanded but issues at its original pressure. The nitrogen is heated and then expanded in a gas engine to furnish power to drive the plant; thus no outside power is required, as the heat applied to the nitrogen develops all that is necessary to drive the compressors.

It is possible also that the centrifugal method of separating the gases of air may be made a commercial success. This acts on the difference in weight of oxygen and nitrogen. It should be noted that a mixture of oxygen and nitrogen will do so long as the oxygen is in excess.

Effect of Increasing Pressure

It is known that increased yields can be obtained by increasing pressure in the reaction chambers of arc furnaces, but hitherto the pressures used have been sufficient only to move the air quickly through the arc. Extra pressure means more power to drive the centrifugal compressor, and the question is whether a larger plant requiring more power to work it would be justified by the increased yields obtained. Concentration is about doubled at 100 lb. pressure.

In any case there is no need to use such "heroic" high pressures as 1500 to 2000 lb. per sq.in. (100 to 135 atmospheres) which are necessary for the Haber process of making synthetic ammonia. Such pressures can be dealt with on a laboratory scale, with small tubes and apparatus, but they are troublesome on a large scale. It is difficult to retain hydrogen and to prevent it forming an explosive mixture with oxygen, also it occludes into the steel casing and makes it brittle.

Air at high pressure has a greater insulating value than air at low pressure, as shown by the fact that sparking between the metal quadrants of an electrostatic voltmeter may be stopped by merely increasing the air pressure. Owing to lower pressure at high altitudes the corona effect on transmission lines is also more pronounced.

It should be noted that a small pressure is caused by the explosions from the arcs in the furnace. When a furnace is first started up these are very pronounced and of varying intensities, but after the furnace is heated the explosions become less intense and more numerous.

Absorption

Fig. 17 is a diagram indicating the approximate temperature of the gases as they pass through the system, when it is desired to make nitric acid. Boilers reduce the temperature from about 1000 deg. C. to 250 deg. C., and a heat exchanger then reduces the gases to about

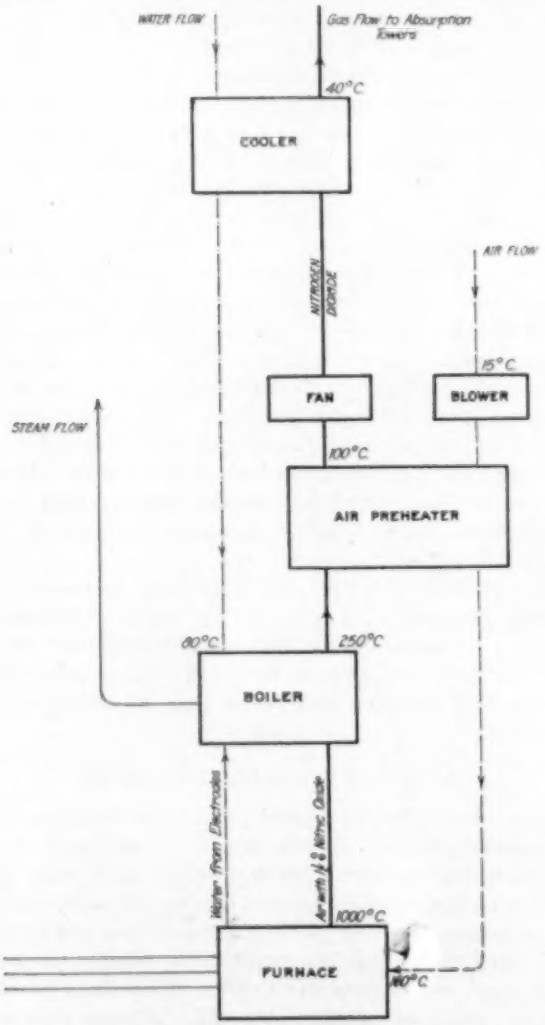


FIG. 17. SHOWING FLOW OF GAS AND AIR AND APPROPRIATE TEMPERATURE

100 deg. Finally a water cooler brings them down to 40 deg. C. or lower. The final temperature obviously depending on the temperature of the cooling water, it would probably be possible in winter to reduce the temperature to about 20 deg. C. The lower the temperature of the gases in the absorption towers, the better is the absorption, and that is the reason why stronger acid is obtained in winter than in summer.

As the gases leave the furnace they are at high temperature and must be carried in ducts lined with firebrick. Between 250 deg. C. and 100 deg. C. steel may be used, but below 100 deg. C it is well to use aluminium or acid-proof stoneware, as silicon-iron cannot be used. The water cooler should also have aluminium pipes, as acid may form. Before the gas enters the towers it is necessary to facilitate the oxidation of all the nitric oxide to nitrogen dioxide, and for this purpose large open spaces are necessary through which the gases can flow sluggishly.

It is of some assistance to have connecting pipes of large cross-section. At Rjukan II, Norway, the furnaces are about 3000 feet (0.9 kilometer) from the absorption towers and the gases are carried through an aluminium pipe about 3 ft. (0.9 m.) diameter. The gases enter the pipe at about 200 deg. C., and are cooled down considerably while passing through it.

With gases at 40 deg. C. and 1.5 per cent nitric oxide concentration, the nitric acid can be easily made to about 33 per cent, which is correct strength for the manufacture of ammonium nitrate and calcium nitrate.

When sodium nitrite is required, the gases must enter the absorption towers at about 250 deg. C., because at this temperature only about half the nitric oxide has been changed to nitrogen dioxide and this mixture when absorbed by sodium carbonate or caustic soda gives sodium nitrite without any nitrate. For this product the absorption towers can be much smaller than those for making nitric acid, and they are also cheaper because they can be made of steel plate instead of acid-proof brickwork. Considerable quantities of sodium nitrite are required for the aniline dye industry, and it is also used for drugs and the pickling of meat, etc.

Cooling the Gas

The chemical reaction of nitrogen and oxygen is reversible, but the tendency for nitric oxide gas to dissociate is only slight at below 1500 deg. C. The problem is therefore to jerk the nitric oxide from arc temperature to below 1500 deg. C. To a certain extent this is performed automatically by the air which surrounds the arc streamers, and it is probably most effective just at the moment when the arc breaks. Passing the air at high velocity through the flame is also advantageous, and at the same time the fixed gas and air should be withdrawn from the top of the furnace by an exhaust fan.

Several ways have been employed for expediting the cooling; for example, in the Pauling type of furnace some of the cooled gases are re-introduced again at a point just above the zone of maximum temperature. Another method is to impinge the top of the arc flame into a cooler, which may take the form of a steam boiler. During experiments with an early model of the K. S. 3-phase furnace, a boiler was set low enough for the electric arc flames to play against the tubes, when it was noted that they flickered about the surface much the same as do the flames of ordinary coal gas, and the boiler was not detrimentally affected. This plan takes advantage of the latent heat of steam, and the cooling is just as good in a large furnace as a small one. The boiler or cooler is connected to earth, but as the center of the flame is the neutral point of the 3-phase system no current passes, as the phases are in balance. As a matter of fact, the bulk of the electrical energy delivered to a furnace passes between the electrodes near the bottom of the flame.

Steam from Boilers

The most economical way to cool furnace gases is to pass them through boilers and to employ the steam so produced for various purposes in the factory, such as

evaporating water for the end products, etc.; also, as indicated below, the steam may be used to generate electric energy and so work regeneratively.

In order to show how much steam can be raised by the heat of furnace gases it may be of interest to give some figures for a plant equipped with furnaces to utilize 10,000 kw. and supplied with about 700,000 cu.ft. of air (20,100 cu.m.) per hour. At atmospheric pressure the volume of air containing 1.5 per cent of nitric oxide gas would be about 12.5 cu.ft. per lb., and therefore 700,000 cu.ft. (20,100 cu.m.) will weigh

$$\frac{700{,}000}{12.5} = 56{,}000 \text{ lb. } (25{,}500 \text{ kg}).$$

Assuming that the air and the nitric oxide enter the boiler at about 1000 deg. C. (1800 deg. F.) and leave at 250 deg. C. (450 deg. F.), then the difference of temperature is 750 deg. C. (1350 deg. F.) The specific heat of air is about 0.24, so the total heat in B.t.u. will be $1{,}350 \times 0.24 \times 56{,}000 = 18{,}000{,}000$ (4,500,000 cal.) Assuming that about 970 B.t.u. are required to evaporate a pound of water into a pound of steam at atmospheric pressure, the steam will amount to

$$\frac{18{,}000{,}000}{970} = 18{,}500 \text{ lb. per hr. } (8400 \text{ kg.})$$

Allowing for loss by radiation through the brickwork setting and the steam drum, the total steam may be assumed at 18,000 lb. (8200 kg.) per hour.

Steam at 125 lb. per sq.in. (8.5 atmospheres) is suitable for evaporating purposes, and if the steam has to be carried some distance it is well to add about 50 deg. F. of superheat, making a total temperature of about

$$350 + 50 = 400 \text{ deg. F. } (200 \text{ deg. C.}).$$

In a very large installation, more steam may be generated than is required for evaporation of end products, and in that case it can be used for generating electric energy. In the latest installation at Rjukan II, in Norway, there are three 4000-kw. steam turbine alternators supplied with steam by the hot furnace gases. It is very significant that in an installation having practically unlimited water power, steam turbines should have been installed, and indicates the saving there would be by combining an air nitrate factory with a power house equipped with steam turbines.

If all the steam from a 10,000-kw. plant was to be used in turbo generators having a steam consumption of say 18 lb. (8.2 kg.) per kw.-hour, then the energy would be

$$\frac{18{,}000}{18} = 1000 \text{ kw.}$$

That is to say, about 10 per cent of the energy put into the furnaces can be regenerated.

The boilers may be of any pattern so long as they are gas-tight, and they may form part of the furnace, or be separate, as in Norwegian installations. The feed water should be hot, so that moisture may not be deposited on the tubes, and for this purpose the water used for cooling electrodes and gases is employed and there is a further saving of heat.

In many discussions on the subject of nitrogen fixation in arc furnaces it has been assumed that the sole factor bringing about formation of nitric oxide is a thermal one. This is very doubtful, however, because all data relating to the laws of thermo-dynamic equilibrium have been obtained at temperatures very much lower than those commonly met with in electric furnaces; therefore it does not follow that the same laws hold good for arc temperature.

Dr. Maxted states, in the proceedings of the Society of Chemical Industry for April 15, 1918, that:

"Purely thermic interpretation of the nitrogen oxide reaction depends on a large extrapolation from lower to higher temperatures, and assumes that no latent factors cause increase or decrease in the observed temperature coefficients."

Some experiments by Mr. J. L. R. Hayden (see Trans. A. I. E. E., 34, 613) lead him to the conclusion that in fixing nitrogen by the electric arc the conditions of thermo-dynamic equilibrium are of secondary, if of any, moment. In other words, the process is essentially an electric one. His experiments were made with electrodes of various material which gave different temperatures, and the order of their nitric acid production was as follows:

Concentration	Boiling Point (Arc Temperature)
Iron—Highest	2450 deg. C.
Titanium	2700 deg. C.
Carbon	3600 deg. C.
Copper—Lowest	2310 deg. C.

It will be seen that although carbon gives the highest arc temperature it is relatively inefficient in producing nitric oxide. Also the iron and copper, which give approximately the same arc temperature, are at opposite ends of the scale in producing oxide.

Another experiment made with the mercury arc, which has a much lower temperature than the above, showed that it was easily possible to get concentrations above those representing thermo-dynamic equilibrium. In electric furnaces there are other phenomena besides that of heat, for example, ionization, which appears to have the effect of disrupting the nitrogen molecules and so facilitating their combination with surrounding oxygen. It is conceivable also that the electric stress due to the high voltage and the magnetic field set up by the currents may have some effect.

Mr. Cramp, of Manchester, found that there was an increase of nitric oxide when ozone was added to the air passing into the arc flame, and it may be that O_3 and the corresponding polymer of nitrogen, which Sir J. J. Thompson calls N_3, are formed momentarily, and then, dissociating, the nascent atoms of oxygen and nitrogen combine.

Platinum Released

Under an order of Nov. 14 from the Bureau of Mines, licenses will no longer be required in connection with the handling of fireworks or the precious metals platinum, iridium and palladium. Many of the numerous chemicals entering into the manufacture of explosives are used constantly for other purposes, and under the new order no restrictions will obtain on the handling of these chemicals when not used in the manufacture of explosives. Licenses are still required for the handling or all such ingredients when intended to be used in explosives manufacture, however,

The explosives regulation was passed by Congress in October, 1917, with the aim of putting a stop to the numerous incendiary explosions and fires occurring at war munitions and other industrial plants.

Helical and Elliptical Springs*

A Discussion of the Manufacture of Elliptical and Coil Springs—Types of Steel Alloys Used—Methods of Testing—Formulae of Calculating Loads, Deflections and Torsion—Effect of Overstrain—Molecular Hysteresis

BY CHAUNCEY T. EDGERTON

A SPRING may be defined as a device for the storage or re-distribution of mechanical energy. That may not be a very scientific definition, but it will at least serve to point the distinction between the two general classes of springs; first, those subjected to transverse stress, and, second, those subjected to torsional stress. Springs coming under class 1 are usually made of flat steel, in which one dimension of the section is much greater than the other. The common example of this class is the usual railroad "leaf" or "elliptic" suspension spring, and a similar type is, as you know, the standard spring for automobile suspension.

This paper will be largely confined to these types, from lack of time to speak of the many interesting kinds of special springs—of volutes, very popular as railroad suspension and buffer springs in Europe and which give such splendid results when properly made; of safety valve springs, which are often ordered to a tolerance of $\frac{1}{64}$ in. on the loaded height, and so carefully made are the springs and so accurate is our working theory that they can be figured almost to a dot; of indicator springs, on which the requirements are so severe that the manufacturers think they are doing well if they get one spring right in ten.

MANUFACTURE OF ELLIPTIC SPRINGS

I will run briefly through the series of operations involved in the manufacture of elliptic springs before taking up a few interesting points connected with the design. The plates are sheared to length cold in a slider-head shear, and then are either punched or nibbed at their center. (Automobile spring plates are usually bunched and assembled with a bolt or rivet. Railroad spring plates have a little conical nib pressed up in the center; the nibs of adjacent plates nest into each other and lock the plates together.) Next the main plate of the spring has an eye rolled up on each end, or else it has a drop-forged pad welded to each end, or some other means is provided for engagement with the hangers. Usually two or three plates besides the main plate are cut the full length of the spring; the remainder of the plates are regularly shortened, or "stepped." These are usually tapered down at each end in tapering rolls, and trimmed off square, half round or pointed. The plates are then ready to be fitted.

From time immemorial, elliptic springs have been fitted by hand. Even now the great majority of railroad springs are so fitted, while with automobile springs, the proportion of those machine fitted is somewhat greater. Spring fitting is more nearly a skilled labor proposition than any other major operation in a spring mill, and a good fitter is a fairly well-paid mechanic.

Elliptic springs of alloy steel are hardened and drawn in pyrometer-regulated furnaces and baths, but carbon steel springs (that is, the vast majority of railroad elliptics) are hardened and tempered in a single operation, each plate going into the tempering oil as soon as it is fitted, without being re-heated. The hardening medium used is rather mild—either common black mineral oil or something like "Haughton's Soluble," and it should be hot—about 300 to 350 deg. F. The "drawing" operation varies in different shops. Many good fitters "flash" the plates; that is, they withdraw each plate from the oil after an immersion of about half a minute, so that it still retains heat enough to ignite the oil which adheres to it. Of course the flashing itself does nothing to the steel; it is simply an indication that the plate retains heat enough to draw itself down to a spring temper. Other fitters leave the plates in the oil until cold, and then draw them in a low-temperature furnace to the proper color. The plates are then ready to be banded or bolted together, and the spring tested.

It is surprising to find what excellent and uniform results a good fitter will obtain with this seemingly primitive method of heat treatment. When I was conducting experimental work in the shops, I used to go around occasionally after the fitters had gone home, and steal half a dozen tempered plates at random from their tables. The next day I would give these a transverse load test; and while they would not average up quite so well as heat-treated plates, I would find occasional specimens which on static test would equal the best results I could obtain from the most careful heat treatment. There is, of course, no good reason why this should not be so. The one great advantage obtained from careful heat treatment is uniformity. If the average excellence of the various plates in an elliptic spring determined the life of the spring, the advantages of special heat treatment over the handiwork of a first-class spring fitter would be but slight. The trouble is that an elliptic spring is only as strong as its weakest plate.

I also used to test these flat plates to destruction under repeated loads, alternating from zero to a fixed maximum stress. In these tests the difference between hand-tempered and specially treated plates was more marked than in the static tests. Pyrometer treatment would usually give a fairly uniform life before failure, while the life of hand-tempered plates was decidedly erratic.

All springs made from alloy steels are given special pyrometer heat treatment. After the plates are fitted they are allowed to cool, and are then reheated in a

*Read before the Pittsburgh Section, American Electrochemical Society, May 10, 1918.

special furnace, preferably of the muffle or semi-muffle type. They remain in the quenching oil till cold, and are then drawn to spring temper in a lead or salt bath or a low-temperature furnace also regulated by pyrometer. In some automobile spring shops I understand they provide a bank of three furnaces for each fitter—one for heating to fit, one for heating to quench and the third for drawing. Personally I prefer to make the heat treatment an independent operation. I had excellent success with a treating furnace built as shown in Fig. 1. These furnaces heated uniformly and quite rapidly—much more so than a muffle fire. It is important to have the heating chamber amply large. If it is too small or if the arch is too low, the heat will be "spotty" and it will be very difficult to bring a charge of any size up to heat without losing control of the temperature.

Speaking from a commercial standpoint, the problem of high temperature regulation and measurement is not so much a question of knowing what temperature you have in your furnace as of insuring that the work, or charge, is at furnace temperature. This is particularly true with material like elliptic spring plates, which have to be handled very gingerly when they are hot, so as not to change their camber and destroy the "fit." It is necessary to put a number of these plates into the furnace at a time in order to secure reasonable economy

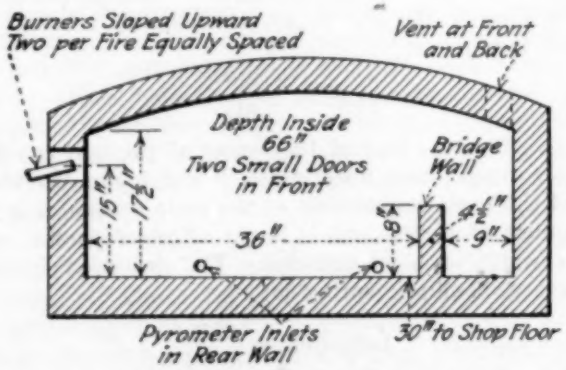


FIG. 1. CROSS-SECTION OF HEAT-TREATING FURNACE, LOOKING TOWARD REAR

of operation; and as it is impracticable to have more than one or two pyrometer fire ends in each fire if you are operating a bank of fires, success depends much on the experience, skill and judgment of your pyrometer man.

As far as the actual reliability of the pyrometers is concerned, good results may be obtained in any one of several ways, but they all involve much care and constant checking. I still believe that the way I adopted when handling this work was the best. After several heart-rending experiences I bought a first-class high resistance millivoltmeter, had my own couples made up by a handy little German machinist in our own shops and calibrated them from a "standard" couple, thoroughly seasoned by long exposure to high temperatures and calibrated direct from three or four freezing-points. The points used were those of eutectoid steel, common salt, sodium sulphate and barium chloride. These gave a range covering the quenching temperature of any kind of spring steel; they were materials easily obtained and with well-defined freezing points. This practice took considerable time and cost some money, but the results were worth it.

For the drawing operation there is nothing like a lead or salt bath. A furnace is difficult to regulate at the low temperatures desired, owing to the small body of contained heat in the furnace; whereas a lead bath such as we use in a spring shop contains two or three tons of lead, making a heat reservoir capable of very accurate control and yet capable of being brought up to temperature in a reasonable time.

Composition of Spring Steel Plates

The standard analysis of carbon spring steel is:

Carbon	0.90 to 1.10 per cent
Manganese	Less than 0.50 per cent
Phosphorus and sulphur	Less than 0.05 per cent

For carriage and wagon spring work the carbon is often lower, so that the plates can be dipped in water. For railroad elliptics most mill men prefer carbon not over 1 per cent. You are all doubtless familiar with the long standing prejudice in favor of low phosphorus and sulphur. I am more afraid of high manganese in spring steel than of high phosphorus. I believe some authorities claim that it takes about 0.25 to 0.30 per cent of manganese to thoroughly de-oxidize the melt, that this is the sole function of the manganese content and that any higher manganese serves no good purpose. I have always obtained best results from steels running 0.30 to 0.40 per cent manganese; toward 0.50 per cent I begin to look for trouble.

Of the alloy steels the favorites for high grade elliptics are chromium-vanadium, chromium-nickel and silico-manganese. These are used mostly in automobile work, although a few railroads use chromium-vanadium steel for some or all of their elliptic springs. The Ford people claim that after exhaustive experiments they have demonstrated chromium-vanadium to be the very best for springs, and they use nothing else. Several other leading automobile concerns use the same types; perhaps a larger number use silico-manganese. There are several varities of chromium-nickel spring steel, but not much is used, and I know very little about it from personal experience.

Chromium-vanadium spring steel, as originally proposed by the American Vanadium Co., analyzed 0.40 to 0.50 per cent carbon, about 1.25 per cent chromium, about 1.00 per cent manganese and 0.20 per cent vanadium. This made a very tender material, of most remarkable physical qualities if treated properly, but it is a little difficult to get the right treatment. One of the big producers has kept pretty close to this original analysis, simply reducing the chromium to an average content of about 1.10 per cent. Other steel makers, after lots of trouble with spring makers who couldn't or wouldn't heat-treat properly, now make chromium-vanadium steel containing about

0.43 to 0.52 per cent Carbon
0.80 to 1.10 per cent Chromium
0.60 to 0.80 per cent Manganese

still it is quite tender. That and its cost are the two objections to its use in springs. If properly treated and cost is no object, it is a wonderful steel.

Silico-manganese spring steel, as usually made in this country, is modeled after the French Le Moyne and the Austrian Poldhi steels. The analysis is:

Carbon	0.50 to 0.60 per cent
Manganese	About 0.80 per cent
Silicon	1.80 to 2.00 per cent

This is not so tender a steel as chromium-vanadium. Some metallurgists are skeptical about the anti-fatigue qualities of silico-manganese steel, but it is in high favor as an automobile spring steel, and with the most ordinary care in heat treatment will make a very good record.

Testing Elliptical Springs

Before passing on to helical springs, just a word or two about the testing of elliptical springs. The usual design-stress for railroad elliptics is 70,000 lb. per sq.in., under the carbody or engine load; and it is customary to give the springs a static test before shipment of 50 to 100 per cent over the working load. Autographic tests on springs in service indicate that on an average roadbed a well-designed spring will suffer a maximum deflection under shock and vibration of not more than 50 per cent in excess of the static deflection under carbody load. Frequently, however, the vibration due to inequalities of roadbed cause an absolute deflection in the springs of ½ in., 1 in., 2 in. or some other figure which bears no particular relation to the deflection under carbody load; or, in other words, this absolute deflection would be about the same if the design of the spring were changed so as to make it more flexible or less flexible. But if the spring is made more flexible, any absolute deflection of ½ in., 1 in., 2 in. or whatever the maximum may be will be a smaller percentage of the deflection under rated load; and conversely the percentage will be greater in a less flexible spring. But with the rated load at a fixed fiber stress, this is tantamount to saying that a flexible spring will be subjected to smaller maximum stresses than a stiff spring; consequently the life of the flexible spring will be longer. This all seems self-evident; and yet you would be surprised to find how impervious many spring users are to this simple argument. They will look at nothing but the design-stress for the carbody load; if that is all right, then the spring is all right.

The condition I have just described is greatly exaggerated in automobile service, where the road conditions are far more severe than in railroad work. An automobile spring should be designed so that it will stand an indefinite number of deflections to the point where it will hit the frame or the rubber bumpers.

I have already spoken of the transverse tests I made when engaged in investigation work. I made hundreds of these, both static and fatigue tests, under all sorts of conditions. Needless to say, I obtained some very interesting results, but only have time now to refer to one or two of these.

When the chromium-vanadium spring-steel people began to visit us and talk their product, their favorite piece of propaganda was to take a piece of their steel eight or ten inches long, heat-treat it very carefully and then break it transversely. They would then show us the peculiar long "scarf" formed by the break, the fibrous, hickory-like appearance of the fracture, ask us to compare this with the square break and crystalline structure of carbon steel in a similar test, and invite our reverent admiration for their wonderful steel. This was duly forthcoming until I began to make some fatigue tests on this same steel. Then I found that these plates, tested under repeated loads which were well within the elastic limit, broke with a clean, square fracture, showing no trace of that wonderful "hickory" fiber. What became of this fiber? I have never found a conclusive answer to the question. My own guess is that the fiber is a condition set up by the rolling, which gradually disappears as the metal becomes fatigued.

These fatigue tests would distinguish between "mild" and "tender" steels very consistently. Chromium-vanadium steel would often make an excellent showing in static tests over a considerable range of treating temperatures, but when the same heat of steel was put through fatigue tests the treatment had to be right within a very narrow margin to get anything like maximum results. On the other hand, carbon and silico-manganese spring steels would show long life over a comparatively wide range of analysis and heat treatment.

Calculation of Elliptic Springs

The formulæ for the calculation of elliptic springs, as laid down in the text books, are tolerably correct. The load formula is:

$$P = \frac{2\,Sbh^2n}{3L}$$

where P is the load at the center of the springs, S is the corresponding fiber stress, b and h are the width and thickness respectively of the plate section, n is the number of plates, and L is the effective length, with the width of band deducted. The deflection formula for a semi-elliptic spring is:

$$\text{Deflection} = \frac{3\,PL^3}{48\,EH^3n}$$

E being the elastic modulus of the material. For a full elliptic the deflection will, of course, be twice as great. The deflection formula is approximately correct only when the plates are spaced according to theory. Most mill men use empirical deflection formulæ, and on a lot of any size they set up a trial spring before fitting the lot, as the deflection is subject to several disturbing practical conditions which make it difficult to figure accurately.

Manufacture of Coil Springs

We come now to the second grand division of springs—those which are subjected to torsional or twisting stress. The majority of these are helical springs, or, as they are generally known in the trade, coils. They are further classified into extension or compression springs, according to the nature of the loading applied; this classification has nothing to do with the nature of the stress produced in the material. They are also divided from a manufacturing standpoint into hot-wound and cold-wound springs; if the material is larger than ½ in. round or square they are usually wound hot, while the smaller sizes are wound cold. The material

used may be either round, square or rectangular in section, and our English cousins rather favor certain sections of irregular shape. Railroad bearing springs as used in this country are practically all round-section compression springs, hot wound.

The manufacture of these springs is quite simple. The bars are cut to the proper length, and each end tapered down in a big tapering roll, each of these tapered ends having a length of about three-quarters of a turn of the finished springs. The bars are then wound or coiled on a cylindrical mandrel with just enough taper to permit of sliding the spring off without distorting it. The pitch is regulated by feeding the bars into the machine in direct contact with a revolving grooved worm; where very accurate pitch is required, the bars are fed in through a worm-driven feed carriage, similar to the leadscrew and tool-carriage of a lathe. The springs are then dressed, so that the tapered ends lie flat and square, and are then quenched in the tempering oil. In ordinary commercial work it is not necessary to flash or draw the springs, as the oil gets pretty hot, and the size of the steel is usually such that it does not cool fast enough in the oil to get very hard. The springs are then tested solid, or coil to coil, two or three times, also tested for load if any is specified.

Small lots of wire springs are wound on a lathe in lengths up to the capacity of the machine. They are then cut to length, the ends heated over a little slot furnace and dressed in by hand, and ground to a bearing on an emery wheel. Large lots are coiled in automatics, in which feed-rolls drive the wire onto a stub mandrel, around which it is bent by rollers. The dressing of the ends is done automatically, the "pitch plug" dropping back every so many coils and allowing one coil to be wound close. Some automatics also cut the springs off. On small sizes these machines will turn out two or three thousand springs an hour, coiled, dressed and cut, ready for grinding. It takes some time to set up one of these automatics for a job, so that they are not economical on small lots.

It is customary to draw wire springs after winding to a dark blue color (about 500 to 550 deg. F.). This is termed "blueing." It tends to relieve the strains due to the winding, and also provides more or less protection against oxidation in case the springs are not to be japanned. However, a japanned finish is the usual one for wire springs, and it so happens that a japan which bakes at 500 to 550 deg. F. has just the right elasticity and toughness for spring use. Therefore the operation of baking the japan also serves to draw the springs. In modern wire spring shops the japanning ovens are built large enough to accommodate a small truck fitted with racks, on which the springs are hung after dipping, and the truck is then run into the oven and left until the baking is completed.

Composition of Steels for Coils

Coil springs of alloy steel are heat-treated in practically the same manner as elliptics. The analysis of steel used, either carbon or alloy, is about the same as for elliptics, although carbon steel for coils should preferably run above 1.00 per cent in carbon rather than below.

The manufacture of cold-wound coils is an entirely different matter. You cannot coil 1.00 per cent carbon steel cold, even though you carefully anneal it. Therefore several special grades of "carbon spring wire" are used for making such springs. Most important of these are oil-tempered wire, and hard-drawn or "black premier" wire. The former is a wire running about 0.50 per cent carbon and 0.50 to 0.50 per cent manganese, and is heat-treated directly after passing through the wire dies and before winding on the reel, by being passed successively through a muffle furnace, a quenching bath and a drawing bath or furnace. This tempered wire can then be wound cold on practically any size of mandrel, and can even be battered with a hammer until the wire is bent almost double on itself without breaking. At the same time it is good for a torsional stress of 110,000 to 115,000 lb. per sq.in., in $\frac{5}{16}$ in. or $\frac{3}{8}$ in. round, and a much higher stress in smaller sizes.

Hard-drawn wire is a material of about 0.30 per cent carbon, which has not been annealed after the last few passes through the wire-drawing dies. It is not tempered either before or after winding. This at first sight would appear to be a very low grade material for spring making, but as a matter of fact it produces very satisfactory springs if the stress required is not too high. It is rather apt to be non-uniform, a condition which I have been told is usually due to failure to replace the wire-drawing dies as they become worn.

Another grade of spring which used to be common was bessemer wire, used for making cheap furniture springs. I know about this material only from hearsay, as there never was a pound of it in any shop with which I was connected. I believe it is now going out of use.

In addition to these carbon wire grades and one or two others which are used for special purposes, chromium-vanadium and silico-manganese steels in the usual wire spring sizes can be wound cold, and in sizes around No. 15 and smaller can usually be wound after tempering. These alloy steels, when intended for manufacturing into wire springs, should be electric furnace or crucible products.

Torsional Theory of Coil Springs

Next I want to say a few words about coil spring design, and will first point out that with experience and attention to detail it is possible to obtain very accurate results from the application of coil spring theory to practice; much more so than in the case of elliptics. The stress is considered as pure torsion, the small transverse load component being neglected. For compression springs of round bars the formulæ are:

$$\text{Load} = P = \frac{S\pi d^3}{8M} \quad \text{and} \tag{1}$$

$$\text{Deflection per coil} = \Delta = \frac{8PM^3}{Gd^4} \tag{2}$$

Substituting the formula for P in the deflection formula, we have:

$$\Delta = \frac{S\pi M^2}{Gd} \tag{3}$$

S is the torsional stress produced in the outer fibers of the section by the load P. M is the mean or pitch diameter of the helix, d is the diameter of bar, and G is the torsional or shear modulus.

Then if the stress S is taken as the maximum allowable for the material, formula 3 will state the maximum value of Δ for the dimensions examined; further.

if the spring is to be capable of testing solid (coil to coil), the value of Δ from formula 3 will also be the "maximum allowable space" or opening between adjacent turns of the spring.

Likewise, formula 1 will give the load carried by the spring when coil to coil; or, as it is usually called, the "capacity" of the spring. The total movement of the spring is the space between turns times the number of active turns. The tapered ends of the spring, being dressed down flat, have no movement, and must not be counted as active turns. Many spring designers overlook this point and get into trouble. There is a wide difference of opinion among authorities as to the proper values for S and G. About this more in a moment.

The formulæ for coils of square and rectangular sections, as given in most of the text books, are fundamentally wrong. They are based on the assumption that these sections retain their shape under torsional stress; whereas you can see in an instant, by twisting an ordinary rubber eraser, that the section becomes warped. The true theory was announced by St. Venant, the French mathematician, who worked out the formulæ for a rectangular section (of which the square is a special case) and for the triangle and ellipse. The problem is a very pretty one in the Theory of Elasticity. It is set forth more or less fully in several English works—I think that of Prof. Burr of Renssalaer Polytechnic is the most complete. The equation for rectangular sections involve infinite series of hyperbolic functions, and are difficult to turn into usable shape. But to illustrate the error in the old formulæ, these give for square sections:

$$P = 0.4714\,\frac{Sd^3}{M}; \text{ and } \Delta = 4.712\,\frac{PM^3}{Gd^4};$$

whereas the correct values are:

$$P = 0.4161\,\frac{Sd^3}{M}; \text{ and } \Delta = 5.58\,\frac{PM^3}{Gd^4}.$$

An interesting result of the St. Venant torsion theory is that the points of maximum stress in a rectangular section are the middle points of the long sides—in other words, the points on the periphery nearest the neutral axis; whereas the old theory assumed that the maximum stress occured at the points furthest from the neutral axis, i.e., at the corners.

Effect of Overstrain on Elastic Limit and Shearing Modulus

A few curious things have been developed by research work on coil springs. In the first place it must be explained that in hot-coiled work it is customary to wind a spring so that it will have a free height considerably higher than the free height specified for the finished spring, this excess free height being removed as "permanent set" in the solid test. In railroad springs the excess free height is from 25 per cent to 100 per cent of the total movement of the spring after the excess height has been removed by the solid test. The average figure is about 50 per cent. The result of this practice is to increase materially the capacity and total movement of the spring. Take as a concrete example the outside coil of a Pennsylvania Railroad class H-24 spring, the dimensions of which are:

Outside diameter = 6½ in.
Free height (final) = 8 in.
Size of round bar = 1½ in.

If this spring were wound 8 in. high, it would test down to about 7¾ in. Other results would be about as follows:

Free Height As Wound.	*Free Height After Test.*
7½ in.	7½ in.
8 in.	7¾ in.
8¼ in.	7⅞ in.
8½ in.	8 in.
10 in.	8¼ in.

By winding the spring 11 in. high, we could perhaps gain another ¼ in. in final free height, but the springs would probably be crooked after testing.

At the same time, an increase in winding height gives an increase in the capacity of the spring, but the increase in capacity is not as great proportionally as the increase in final free height. Thus we have increased the apparent elastic limit of the material. What has actually happened is this:

Let Fig. 2 represent the end view of a round bar fixed in a torsion machine, and let the line *OA* represent two radial elements in the same longitudinal plane and at opposite ends of the bar. Now suppose one end of the bar twisted so that the element *OA* at that end takes the position *OB*, the other end of the bar being fixed. Assume that the peripheral distance *AB* exactly corresponds to the shearing strain in the material when stressed to the elastic limit. Then the element *OB* will return to the position *OA* when released, as none of the fibers have been stressed beyond the elastic limit. But suppose the bar twisted until *OA* takes up a position *OC* beyond *OB*, and fix a point *D* which is twisted around to *E*, the curved distance *DE* being equal to *AB*. Then all fibers between *E* and *C* have been stressed beyond the elastic limit, and tend to take permanent set; while the fibers between *O* and *E* have not passed the elastic limit, and tend to return to a position *ODF* on release.

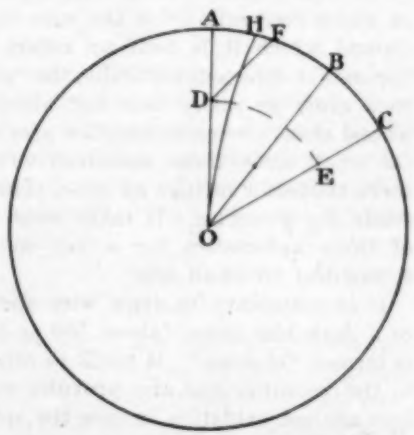


FIG. 2. ROUND BAR IN TORSION

But in attempting to take up this position, the fibers between *D* and *F* are sheared past each other. This shear is entirely distinct from the shear between adjacent cross-sections, which is the only one considered in the usual torsion theory. As a matter of fact, these two shears—the one between adjacent sections attempting to maintain the element in its position *ODF* and the other between adjacent fibers of the same section and tending to return the element to its original position *ODA*—are opposed to each other. The element will then come to equilibrium in some hypothetical position *OH*. In other words, we have raised the apparent elastic strain limit of the bar in the ratio of *AB* to *HC*.

I have never attempted to construct a mathematical formula defining the position *OH*. It is not strictly a

mathematical problem, as we must know first the exact position of *F* in terms of *AB* and *AC*, which in turn involves the behavior of the material under stresses exceeding the elastic limit.

Now you can see what has happened to the H-24 spring, when tested down from an original height of 9 or 10 in. If wound to a height of 7½ in. the true elastic limit would not be exceeded and the spring would not lose any height in testing. If wound 9 in. high, it took a set, but the "apparent" elastic limit and the free height were considerably increased over that of the spring wound at 7½ in. as a result of the application of overstrains.

As soon as I got to work in the laboratory on this "theory of overstrains," I discovered some curious facts. In the first place, they reduce the life of the spring. An H-24 spring wound 7½ in. high will stand so many thousand solid tests before failure. If wound 9 in. high it will survive only about one-half as many solid tests; and if wound 10 in. high, only about one-quarter to one-third as many. Again, the raising of the apparent elastic limit by overstrains carries with it a reduction in the apparent shearing modulus. The diagram explains this at once; the modulus is a stress by strain ratio, the stress used being that in the outer fiber, and the ratio remains constant only so long as the original radial elements remain radial. This is the reason why you will find so many different values given in the text books for the shearing modulus as applied to steel coil springs. One will tell you it is 12,500,000, another 11,500,000, still another 10,500,000. As a matter of fact, the true modulus is 12,000,000 to 12,500,000; the apparent modulus may run down to less than 10,000,000 in a spring which is wound very high. In designing or checking a design, the apparent modulus has to be chosen with very careful regard to the height at which the spring is wound.

Molecular Hysteresis in Overstrained Coils

It is almost universal practice to make load tests of coil springs on "compression"—that is, going down from free height to solid height. But a few years ago the Navy Department decided that it would be well to have their springs tested on "release," i.e., coming up from solid to free. It immediately developed that the loaded height of most coil springs under any assigned load, if taken on release, was less than if taken on compression. A similar phenomenon is found in testing elliptics, but here the difference between the tests is obviously due to friction between the plates of the spring, which of course have to slide over each other when the spring is deflected. Some one then conceived the idea that in the case of coils the difference between tests was due to friction between the bearing surfaces of the spring and the plates of the testing machine, since a coil spring winds up slightly when it is compressed. So we rigged up a ball-bearing device to remove this friction, but it did not have any appreciable effect.

Then an investigation soon found that this difference between release and compression tests was related to my theory of overstrains. If the true elastic limit of the metal has not been exceeded in the original solid tests, there is substantially no difference between release- and compression-load tests. With increase in overstrain the difference in question increases rapidly, until with a rather excessive overstrain it is about 25 per cent of the deflection of the spring under an average load. The explanation of the difference remains a mystery, but evidently there is a mechanical hysteresis present in overstrained coil springs.

That the phenomenon is due to some internal condition of the metal is indicated by the fact that we can wipe out a considerable proportion of the difference between tests by giving the spring a second draw after testing it solid at a somewhat lower temperature than the original draw. I stumbled on this fact by accident, and then made a complete series of experiments on it. The results obtained by this second draw are somewhat erratic, but one can always increase the height for a given load on release-test perceptibly, and usually the gain is about 50 per cent of the difference between tests when the spring is not given the second draw. Strangely enough, this expedient does not affect the compression test to any great extent, but only the release test.

Finally, I would like to mention an interesting verification of the theory of overstrains. It has been pointed out in connection with the St. Venant theory for rectangular bars in torsion, that the points of maximum stress are the middle points of the long sides. Evidently, then, when overstrains are applied to a spring made of square or rectangular bar, the proportion of the section which is overstrained a given amount is much less than in a round bar spring. We should therefore expect the elevation of apparent elastic limit to be more marked in square bar springs than in rounds. This is exactly the case. For rounds of ½ in. to 1 in. bar, the apparent elastic limit after large overstrains would run about 110,000 to 120,000 lb. per sq.in. for commercial work; whereas in squares of the same sizes and under the same conditions we could get 130,000 to 140,000 lb. per sq.in., and with rectangular bars of wide, thin section some almost fantastic figures can be obtained.

There is practically nothing about overstrains in text books as regards either springs or any other branch of mechanical theory. Certainly our knowledge of the fundamental truths underlying the Strength of Materials Theory is in a state far from satisfactory. My own idea is that the problem will be found to be a molecular or an atomic one, and chemists and physicists will have to come to the rescue. The man who writes the "Mechanics of a Molecule" or the "Mechanics of an Electron" will throw a flood of light into many dark corners of engineering theory into which we have to venture every day.

Crucible Steel Co. of America,
Pittsburgh, Pa.

Licenses to Enemy Patents

The I. E. du Pont de Nemours & Co. of Wilmington, Del., filed application on Nov. 22 for the use of German owned U. S. patent rights on the following:

"Producing Ice Colors," "Stable Indigo-White and Process of Making Same," "Compounds of Leuco Vat Dyes With Aralkyl Compounds and Process of Making Same," "Reducing Indigo Coloring-Matters," "Aromatic Ammonium Compounds and Process of Making Same," "Azo Dyes from the Arylamids of 2.3-Oxynaphthoic Acid and Process of Making Them," and "Condensation Products from the Arylamids of 2.3-Oxynaphthoic Acid and Formaldehyde and Azo Dyestuffs Therefrom and Process of Making Same."

Refractory Products*

By A. Malinovszky

Refractory ware may be satisfactory in one furnace under one set of conditions, whereas it may not meet the requirements in another furnace with different substances and under a different set of conditions. Today many types of refractory materials are on the market in the form of bricks, crucibles, etc., which are manufactured from different substances for different purposes as required in various lines of industries. These refractory wares must resist different heights of temperature, depending upon the particular use to which they are put.

It has been demonstrated by different authors that some refractory wares will melt and frequently volatilize at heats where others remain intact, due to certain conditions existing within the furnace. Some refractories carry a load when exposed to a high heat at which others collapse. The success of refractories in operations where high temperatures are employed and the economical advantages to be derived from them are so intimately connected with the material employed in building crucibles or furnaces that it is important to know how to select a material possessing the properties which will enable it to withstand the required conditions. It is particularly difficult to obtain a material which will serve satisfactorily under conditions in which high temperatures are combined with the action of acid fumes, or alkalies, which act as a flux and produce chemical reactions tending to lower the refractory properties of the ware.

Refractories that are high in silica will carry loads at high temperatures satisfactorily, but are particularly susceptible to the combined action of heat and certain acids, alkalies or slags. A fire clay ware containing a high percentage of free silica, when it comes in contact with substances containing fixed bases, suffers a deterioration in its refractory properties, owing to the fact that bases will combine with free silica and will form fusible silicates at low temperature. The chemical effect of substances containing low fusible oxides of metals upon refractory ware, such as glass pots, crucibles or other utensils, is not always readily detectible and is due largely to the action of salt vapors and flue ashes.

Refractories should be composed of materials burned at high temperatures which are strong enough, when molded into ware, to hold at a high heat their contents and weights without distortion. A first class fire brick should carry a load of about fifty pounds to one square inch at 1350 deg. C. It is important for fire brick, especially, to reach their greatest degree of hardness and to contract to their full extent before they are used in a furnace.

The degree of fusibility of a refractory ware depends upon its chemical characteristics, its elementary composition and texture and its physical properties. In other words, fusibility is not only influenced by the elements which enter into the combination of the substances and the proportion in which they are combined, but also by the properties of the compounds or mixtures of various minerals. It appears that the property of easy fusibility in refractory material depends, first, upon the nature of the complex compound bases such as the alkaline earths and the oxides of metals; second, upon the proportion which exists between silica and alumina; third, upon the shape and fineness of the grains; and, fourth, upon the physico-chemical changes which take place when the material is under fire.

It is well known that the alumina is the clay base which forms one of the most highly refractory materials when the content present is high enough to resist slagging and heat actions. It is such material that is extensively used for commercial and technical purposes. The refractory quality of fire clays is increased by the addition of finely ground bauxite or flint clay. It must be understood that not all bauxites and not all flint clays are suitable. Pure materials must be had and they are of limited quantity.

Refractories may be divided into three different classes, acidic, basic and neutral. I think that purely acidic or basic conditions very seldom exist in a furnace, if ever at all. Acidic refractories are made from pure quartz known as ganister, or quartzite. As silica possesses no plasticity, it has no binding property. Some manufacturers use clay as a binder, though it is not a very satisfactory binder for silica brick. The colloidal clay shrinks enormously upon heating and the silica expands considerably. When the brick is reheated, the silica will continue to expand and the clay to contract. These two physical properties work contrary to each other, producing a porous ware having a very weak and loose structure.

The best results are obtained with lime, which is used the most at present. From 1 to 2 per cent of lime is added in the form of milk of lime. Mixed with the finer silica particles, it envelops the coarser silica grains and at high heat sinters the grains together into a strong body in the form of a net-like structure through the mass. Some authors state that the flux forms calcium monosilicate, $CaSiO_3$, which is known as wollastonite. However, the writer believes that there must be different calcium silicates present in the magmatic solution of a silica product. The best results in the manufacture of silica brick are obtained by heating the brick to cone 20, at which temperature the greatest part of the silica is converted to crystobalite and tridymite. It can be said that nearly all the fire clays are acidic, as the silica is dominant in nearly all of them.

Basic refractories consist of magnesite, dolomite and limestone. Limestone has high refractory properties, not being fused or softened (except in the electric furnace), but on account of the properties it possesses, in that the calcium oxide readily reacts with CO_2 to form calcium carbonate and crumbles, it has never come into great commercial use. Dolomite is calcined, ground and mixed with tar, molded under pressure and heated to a high temperature. The calcined dolomite is also mixed with slag and used in the open hearth furnace, by merely throwing it into the furnace with a shovel, to protect the walls of the furnace.

Magnesite requires a greater heat for calcining than limestone or dolomite to expel all the carbon dioxide and is usually exposed to white heat. After cooling it is ground and mixed with a low calcined magnesite or some other binder and then molded into brick under enormous pressure with a hydraulic press and heated

*A paper read at the meeting of the American Chemical Society, St. Louis, Jan. 7, 1918.

to a very intense heat. Magnesite is very refractory and resists metallic action, but fuses readily in contact with silica. The same is true of limestone or dolomite. Magnesite is a good heat conductor and is for this reason very suitable for metallurgical work as well as for the lining of electric furnaces. Magnesite brick under load at high heat will collapse. When exposed to sudden changes of temperature, it spalls very badly on account of its density and friability.

Neutral refractories are those which resist silica and oasic oxides. Graphite, chrome and some bauxite with pure fire clay mixtures are representative of these. Bauxite in its raw composition is a hydrated alumina, containing a varying proportion of impurities, as silica and iron. On heating, the water is driven off and the impurities, as silica and iron, increase in quantity, which tends to nullify the refractory quality of bauxite. The content of water varies from 6 per cent to 34 per cent and that of iron from 1.5 per cent to 30 per cent. Bauxite before it is used must be calcined at a very high heat, from 1200 deg. C. to 1350 deg. C., and again must be repeatedly heated before all the contraction has been obtained. Carbon refractories are made by mixing graphite or charcoal or coke with a good plastic fire clay and burning at a high heat. Oxidizing conditions must be avoided when carbon ware is burned.

Chrome brick, made of chrome iron ore, is a very valuable refractory, as it has the property of resisting both acid and basic slags. Therefore, it is used in furnaces as a neutral lining between acidic and basic refractories. The writer has had experience in open hearth furnaces where silica bricks were placed directly upon magnesite bricks. Where the two different refractories come in contact with each other, a protective layer of calcined dolomite from 12 to 18 inches thick is placed so that the heat cannot be raised to flux them. Chrome brick is very valuable in repairing furnaces when they are under a high heat, as it resists sudden changes of temperature, but will fail and give way at high temperature under high loads the same as magnesite.

Refractories are also made from rare minerals containing zirconium, thorium, yttrium and berylium oxides. Among these zirconia is the most developed for refractories, as it has a very high melting point, nearly 2000 deg. C., and resists all acid and basic slags. Its heat conductivity is very low. Zirconia is produced from the mineral known as baddeleyite from Brazil.

A very important factor which must not be overlooked is the mortar in which the bricks are laid. Refractory bricks made from fire clay should be laid with the same clay the bricks are made of, mixed with fine ground brick or grog to decrease the contraction. The mortar for laying silica brick should be very high in silica and low in alumina and other impurities as iron, lime, etc. Magnesite brick should be laid with magnesite mortar or with dry magnesite powder.

Care should be taken when building furnaces to select the right kind of material and mortars, especially in open hearth regenerators, blast furnaces, cupolas and coke ovens, where the mortar may give away and the strong draft deposit the destructive cinder slags in the joints, where they accumulate and, acting as a flux, fuse large cavities in the brick, thus weakening the whole structure. Therefore, if we test the refractory ware against cones, we should test the mortar at the same time, as it should be borne in mind that a high aluminous mortar for silica brick will act as a flux and slag the brick. The alumina content should be by no means greater than 10 per cent. We also have to keep in mind that refractories with a close texture and fine grain will the better resist abrasion, attack of fluxes, fumes, vapors, slags, flue dust, etc. Refractories with open structure and coarse grain will best stand sudden changes of temperature, but will disintegrate very quickly in contact with salt fumes, slag, flue dust, etc.

As seen from the foregoing, texture is a very vital point. It is well to know where and in which part of the furnace it is most suitable to use brick with a close texture.

I believe that if all engineers, chemists, metallurgists or any firm using ceramic wares would join the American Ceramic Society, many of the defects of present ceramic wares could be eliminated. The society will be of great value with its membership of trained technical and practical men who are capable of solving the difficulties which confront those engaged in any line of industry using fire brick or stone ware. Many firms believe that any college-trained chemical student who is able to make an analysis of clay should be capable to work out ceramic problems. Technical men with a chemical and scientific education will be lost in ceramics until they have had practical experience. It is a great mistake to employ students (as I have seen in most iron and steel works) with the expectation that they are equipped to work out ceramic problems.

It is beyond the ability of the average chemist to conduct a proper analysis of a clay. An analysis of such complex substances as clay, or any other ceramic material, should be made by experienced ceramic chemists. We should welcome heartily the wider knowledge and the progress in ceramics which will attend the growth of the American Ceramic Society.

Lincoln, Ill.

To Expedite Demobilization of Soldier Chemists

As hostilities cease we naturally must again turn to peace-time conditions and look forward to the future development of chemical industry in America. The problem now before the Industrial Relations Branch of the Chemical Warfare Service is to assist chemists in service to secure positions where their training and experience can be used to the best interests of the Government. This enormous readjustment is rendered possible through the information gathered by Dr. Charles L. Parsons, secretary of the American Chemical Society, and through the questionnaires sent out by Major F. E. Breithut of the Personnel Division of the Chemical Warfare Service.

To accomplish results chemists now in military service who desire to return to chemical industry are being requested to inform the chief of the Industrial Relations Branch concerning their future prospects, and manufacturers are being asked to designate their requirements for chemists. The administration of this work will be carried out by the Industrial Relations Branch and information may be obtained by writing to Major Allen Rogers, Chief, Industrial Relations Branch, Chemical Warfare Service, 7th and B Streets, N. W., Washington, D. C.

Quicksilver Operations at Monte Amiata, Italy

The Italian Deposits Were Opened in the Twelfth Century, but Were Dormant After the Crusades Until 1860—Most Important Operations at Present Are at Siele and Abbadia San Salvatore—Preparation of Ore Furnaces in Use

By Dr. Roland Sterner-Rainer[1]

DISCOVERIES of stone hammers, arrowheads, wooden plates and coins made upon opening the old workings around Monte Amiata show that these mines were worked for cinnabar by the Etruscans and later by the Greeks and Romans. (These relics are preserved in two small museums by the managements of Siele and Cornacchino.) At Morone some mining was carried on in the twelfth and thirteenth centuries. War and pestilence closed the mines and they were reopened only in the middle of the last century. They gained importance but slowly because of the tremendous production of California. From 1860 to 1874 only the Siele works were in operation. One year later the Solforate Schwarsenberg began producing in a small plant which was closed in 1885. Cornacchino produced in 1880, and in 1887 Reto or Monte Buono followed suit. Twelve years later the plant of Abbadia San Salvatore was opened and in the following year took over the abandoned Corte Vecchia. In 1906 the Siele plant opened the deposits of Solforate Roselli, in 1908 those of Petrineri, near Bagni San Philippo, and in 1909 those of Morone, near Selvena.

Situation of Workings

At present the district of Monte Amiata embraces seven plants belonging to five companies, and the Cerreto Piano property at Pereta is being developed.[2] The new "Merkur" company, financed by the banking interests of Bleichröder, of Berlin, have been endeavoring for the past year to prove the extension of the old ore body in the trachyte district south of Abbadia San Salvatore. These efforts, though extensive, have been unsuccessful so far.

None of the plants is situated on a railroad. The nearest railroad point is Monte Amiata, on the line Grosseto-Asciano-Siena, from where the 20-kilometer mountain road leads to Santa Fiora, picturesquely situated on the banks of a stream of the same name which flows along the southern slope of Monte Amiata. After covering an additional 15 kilometers, Abbadia San Salvatore, Siele, Catellazzara and Cornacchino are reached. A second railroad point is Chiusi, on the Rome-Florence Railroad, from where a 40-kilometer road leads through vineyard and chestnut groves to the various plants.

The most important deposit is that of Abbadia San Salvatore, situated on the east slope of Monte Amiata, a well-wooded mountain of 1734 meters elevation. The deposits lie in a north and south direction, as do those of the other properties. The mineralized zone[3] is found in the lower Jurassic, the Eocene and the Pliocene sandstones. It has been found that the ores are richer and more abundant the more argillaceous the limestone and the nearer to Monte Amiata. Since the ore is horizontally disposed and outcrops at many points, meteoric waters "filter" into the mines, giving rise by chemical reactions to a strong evolution of carbon dioxide and hydrogen sulphide gas. Excepting the two most northerly mines, Abbadia San Salvatore and Petrineri, all of the mines suffer to a greater or less extent from this evolution of gas.

San Salvatore Most Important

In the beginning of the '80s the German geologist Dr. Schwartzenberg studied the region about Monte Amiata, and finding cinnabar in the creek gravel of San Salvatore, acquired property in the neighborhood for mining purposes. For several years an open cut was worked, when the dwindling ore reserves necessitated deep mining. In a short time the primary ore body was located. The geology has not been completely worked out, but new light will probably be thrown on the geological relations when this ore body has been opened on deeper levels. Ever since then the mine has grown in importance and has long been the most important of the district, producing 20,200 flasks of quicksilver in the last year, as against 19,880 flasks of the previous year.

The faces of drifts and crosscuts are sampled before stoping is begun, as the clay often hides the cinnabar, making it difficult to judge the ore by eye. Besides this average ore, which constitutes the greater tonnage mined, a rich shoot of 30 per cent ore is being stoped. Despite the enormously greater tonnage of average ore, one-fourth of the mercury production is derived from the high-grade ore. Rich pockets are worked individually. The ore is hand-sorted underground and premiums are given to the miners to insure their interest in the sorting process. The minimum content of the sorted ore is placed at 12 per cent, while the average content is around 18 or 20 per cent. This ore is trammed to drying floors and furnaced separately, as it is believed that longer roasting is necessary for higher grade ores. All ores are trammed to the "deposito," on a centrally located tramming level; the ore is lowered to the tram

[1] A portion of a paper on "The Present Status of Quicksilver Metallurgy in Europe," translated by C. N. Schuette from Oesterreichische Zeitschrift für Berg- und Hüttenwesen, Vol. 62, 1914, p. 529. The translation was made in connection with a coöperative investigation of the metallurgy of mercury being carried on by the Bureau of Mines and the New Idria Quicksilver Mining Co., and published by their courtesy.

[2] Z. pr. Geol. 1914, No. 1.

[3] A. Verri, Il Monte Amiata, Boll. Com. Geol. ital., Vol. XXII, p. 9; P. de Ferrari, Le miniere del mercurio del Monte Amiata. Florenz, 1890 (with bibliography); B. Lotti, Die Zinnober und Antimon führenden Lagerstatten Toskanas und ihre Beziehungen zu den quartären Eruptivgesteinen. Z. pr. Geol., 1901, p. 41; V. Spirek, Le gisement de cinabre de Monte Amiata. Publications du Congress internat. des mines, etc., Liege, 1905.

level through offset chutes and is hoisted from the lower levels.

At the reduction plant the ore is dumped on a grizzly of 80 x 100-mm. mesh. The wall rock is hand-spalled and does not have to be dried before being charged to the shaft furnaces. The material that passes the grizzly is fed into the rotary drier, shown in cross-section in Fig. 1, and in perspective in Fig. 2. The temperature in the cylinder is never more than 150 deg. C. The drying gases (generated by burning

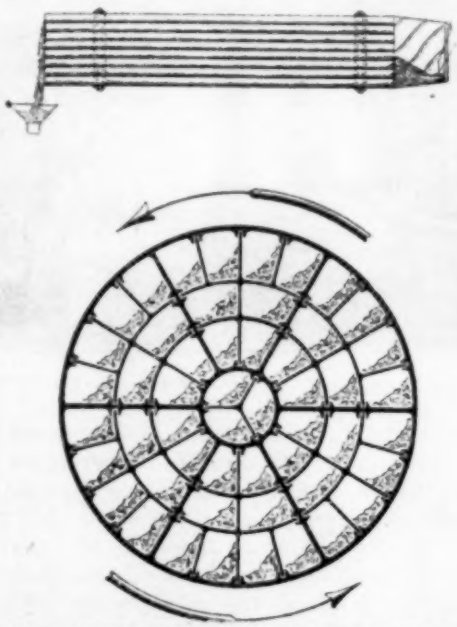


FIG. 1. CROSS-SECTION OF ROTARY DRIER

brush) pass through the drier in the same direction as the ore, and at first contact with the wet ore they are cooled to such an extent that quicksilver losses are not to be feared. A thermometer inserted into the overlapping casing indicates the temperature fluctuation. Screens are fitted to the end of the drum which classify the dried ore into plus and minus 40-mm. sizes. The coarse ore, a hard limestone with a 0.4 per cent mercury content, always equals just one-half of the fines; the fine ore, a mixture of argillaceous dust, clay nodules and shattered limestone, has a content of 0.9 to 1 per cent mercury. The capacity of the drier is 7 tons per hour, the moisture content of the ore being reduced from 15 to 4 per cent. Four men work on the grizzly; one man fires the drier, and two men draw the dried material. A total of 32 men is needed to dress the ore.

Dust Collected and Saved

The moist, dust-laden drier gases pass into a settling chamber where most of the dust is recovered. The last remnants of dust are arrested by a water spray in a second chamber, after which the gases escape. The collected dust is loaded into cars with a belt conveyor and is taken to a wet dressing plant, which seems justified, as this dust would otherwise go to waste. Thirty tons of dust per month are concentrated to a slime carrying 40 to 50 per cent mercury. This slime is treated in two Ferraris furnaces (a hand reverberatory with inclined hearth) and recovers 24 flasks of mercury. The loss in concentration is estimated to be 12 to 16 per cent. It is planned to burn this dust together with all minus 5-mm. material in a rotary kiln furnace built in a manner similar to the rotary drier. From this kiln the gas will pass into a settling chamber, and from this settling chamber will rise the pipes leading to the condensers. If the trials prove successful, several of these kilns will be erected.[1]

The high grade ore and the wet concentrate are dried on drying floors. This was the original method of drying all ores. As was common in the district, the ore was air-dried under roofs, sun-dried and later, with increasing production, the ore was dried on a sheet iron floor, heated from beneath by the hot gases from a grate fire. Since excessive drying caused mercury losses and as the handling of the ore was not only costly and time-consuming but also unhealthful, the former director, F. Ammann, built a "shaft-drier" as far back as 1903. The ore was charged at the top and descended over a zigzag of iron plates. Each knee contained a slit, allowing the moisture to escape into the drying gases. Ammann also originated the four "drying canals," which are not in operation at present, being kept in reserve. These drying canals are heated tunnels, 1.3 x 1.4 meters in cross-section, and 80 meters long, the ore losing its moisture when run through this tunnel on cars having perforated sheet-iron bottoms.

The dried ore is sampled before further treatment. The run-of-mine ores are sampled several times monthly for rough control. The gold cover assay method was used. The pulverized ore is mixed with a small quantity of granulated copper, and heated in a crucible. A half-gram sample suffices for high-grade ore, one to two grams are taken for low-grade ore, while 0.2 gram is

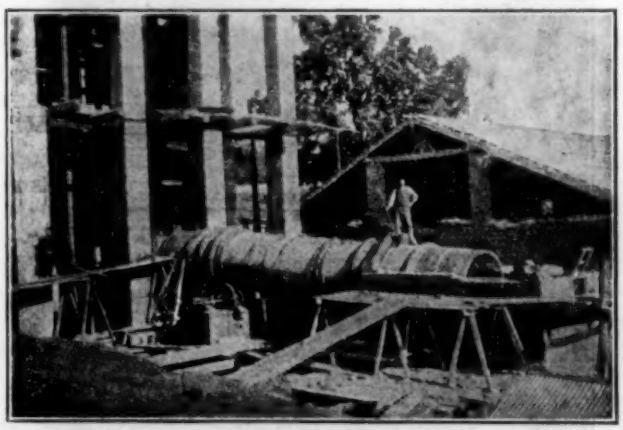


FIG. 2. ROTARY DRIER IN OPERATION

sufficient for pressed soot. The average assay value of the ore treated is 0.8 per cent mercury.

Furnace Practice at Abbadia San Salvatore

At present the plant consists of 14 Spirek shaft furnaces and 6 Cermak-Spirek fine-ore furnaces. The shaft furnaces, Fig. 3, are of identical construction, the

[1] From a letter from Director Trögel, Abbadia San Salvatore, we hear that the kiln has been in experimental operation for two months and that the results have led to several modifications of the plant. When these have been tested—say in the first part of 1914—it will be decided whether this kiln shall be duplicated or whether the Cermak-Spirek furnaces shall be equipped with producer-gas firing, as has been done in Idria. For notes on the use of a rotary kiln at New Idria, Calif., see *Chemical & Metallurgical Engineering*, Vol. 19, p. 239 (Sept. 1, 1918).

circular shaft, 1 meter in diameter, being built of local trachyte. Each has a capacity of 7 tons per 24 hours, 1.5 per cent of charcoal being added to the charge for fuel. An automatic feeding device of local construction insures a fumeless charge-hole.

Four of the fine-ore furnaces which together treat 10 per cent of the ore have a capacity of 25 tons, and two have a capacity of 12 tons per 24 hours. The cinnabar concentrates and the pressed soot are furnaced with the hand-sorted high-grade ore, these charges being more carefully controlled and burned twice as long as low-grade ore. Sluicing of tailings at two-hour intervals is customary in the district by using creek water flowing under the draw doors of the fine-ore furnaces. Only the coarse ore tailings are carried to a dump which has so nearly reached its maximum size that it is proposed to utilize these tailings to fill the mine workings.

Sixty men are necessary to operate the furnaces, the wages ranging from 3.10 to 3.80 lira.[5] The wood is supplied by 18 men.

All furnaces are equipped with Cermak condensers, the parts of which are made by a clever potter of Castellazzara, who furnishes these pipes even to American plants. The soot boxes are arranged, as is customary, perpendicular to the line of the condensers, allowing the first inverted U-pipe to be cleaned every month, while the others are cleaned only at the main clean-ups. All soot found in the system on the furnace

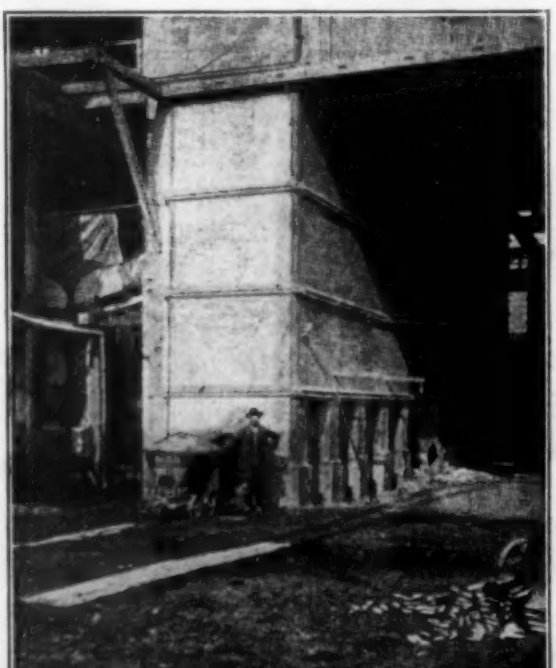


FIG. 3. SHAFT FURNACE AT ABBADIA SAN SALVATORE

side of the exhauster is treated in Exeli soot presses, the mercury content being reduced from 50 to 15 or 20 per cent. The plant has three stoneware exhausters, Fig. 4, installed by the Ton- und Steinzeugwerke of Berlin-Charlottenburg. Two of these induce the necessary draft, while one is kept in reserve. With a consumption of 7.7 horsepower, a rotor diameter of 800 mm. and a speed of nearly 1000 r.p.m., they move 212 cu.m. of air at 21 deg. C.

It may be mentioned that an attempt was made at this plant to shorten the time of bottling the product by measuring the volume instead of weighing the mercury. (Fig. 5.) For this purpose Director Ammann

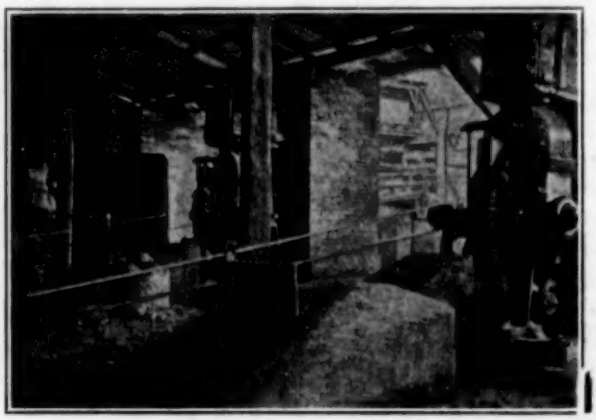


FIG. 4. STONEWARE EXHAUST VENTILATORS

constructed a suitable apparatus and designed curves, giving the volume of various temperatures. This method, however, could not replace the apparently tedious weighing process, because the small gain in time was offset by the inaccuracy caused by the unavoidable temperature variations during the manipulation.

Losses do not worry the management at Abbadia San Salvatore; in fact, the output of mercury is greater than the indicated ore content obtained from the sampling and assaying. It is not possible to say where the error is made without an intimate knowledge of the method of calculating the input. Considering the clean and careful operation of the plant, one would probably not be far wrong in placing the loss at 9 per cent, the figure obtaining at Idria, with which plant it can most readily be compared both as regards ore content and scale of operations.

Operations at Siele

Siele is the second largest producer, with 150 tons of mercury per annum. The ore body is exploited through the mine in the valley of Siele and through the younger Solforate Roselli mine, which lies across the watershed on the drainage basin of the Fiora. The Siele deposits are nearly exhausted, and in a few years the Solforate will probably furnish the entire ore, which is transported to the reduction plant by a cable tramway. In Siele itself the neighboring property is in other hands, which, according to the Italian mining law, is a bar to further development. These ores, in argillaceous limestones of the upper Eocene, are richer than at any other mine in the district, as this crumbly material was most favorable for the deposition of cinnabar. Even though the average ore content is more than 2 per cent mercury, richer ores than these impregnations are found only in small quantities, and it is necessary to sample the ore in place to determine its content, since the cinnabar color is almost completely hidden by the rock. The moisture content is 20 to

[5] A lira is equal to $0.193.

25 per cent, as this is one of the wettest mines. This is also the reason for the gas exhalations and the absence of gypsum, which, excepting for a few small crystals, appears to have been leached away.

After the ore has been dried on drying floors it is passed through two crushers, as the entire tonnage is treated in fine-ore furnaces at present. A 24-ton, a 12-ton and a 3-ton furnace (which burns the pressed soot and the very high-grade ore) suffice to treat the entire present tonnage. The 24-ton furnace treats only 18 tons per day, as the high percentage of fines necessitates a 30-mm. interval between tiles. The 12-ton furnaces, however, can treat 13 tons in 24 hours, as the heating flame penetrates the flues more readily. The disposal of the tailings is also accomplished by means of creek water. The furnaces are cleaned monthly, and the soot of the small furnace treating the rich product is gathered every two weeks. An electrically driven soot mill and the two storage pots equipped with siphons

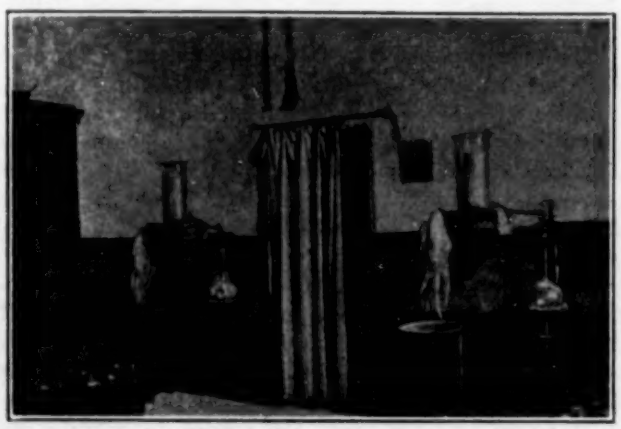


FIG. 5. AMMANN'S MEASURING DEVICE

complete the equipment of this little plant. Formerly, when the dried concentrate was treated in retorts (of which two or three were combined into one branch), the losses were high, but they are today estimated at 5 per cent of the input. The cost per flask of metal is 140 to 145 lira ($27 to $28).

Conditions at Cornacchino

Mining conditions at Cornacchino are even less favorable. Cornacchino is situated near the village of Castellazzara in the drainage basin of the Paglia (Tiber), near the intersection of the provinces of Grosseto Rom and Siena. The mine belongs to "Eredi Schwarzenberg," as does a mine situated some distance to the west across the hills, near ruins of Castle Roccacia. Both of these mines have their own reduction plant. The ores of Cornacchino are siliceous schists impregnated with cinnabar. The original ore body, which was in limestone, had very much richer ore than those mined today, but it has been completely worked out.

During the '80s these ores were burned in shaft furnaces and retorts. It was only when the Cermak-Spirek furnaces became known that the porous and fragile cinnabar bearing siliceous schists of the foot wall could be treated economically. The treatment of such fine ores in retorts or reverberatory furnaces seemed economically impracticable with metal contents as low as 0.35 to 0.4 per cent.

The ore as mined is fairly dry and no artificial drying is needed, as is necessary at most of the other plants. The coarse ore amounts to about one-fifth of the fine ore, so that at present one 24-ton fine-ore furnace and one shaft furnace are used; the latter, however, is in intermittent operation through lack of coarse ore. The developed ore reserves insure a ten-year life of the mine at the present rate of production. The plant can continue operation only if new ore bodies are developed and if wages and the price of wood do not increase further.

The process of dressing the ores which contain 7 to 8 per cent moisture consists of screening them into plus and minus 40-mm. sizes. The minus 40-mm. material contains 0.35 per cent mercury, and the plus 40-mm. material contains but 0.05 per cent mercury. A sample is taken from each car of the screened material as it is brought to the furnace. A twenty-four-hour sample is crushed and assayed for mercury and moisture. Seven to eight grams are used for an assay, which is prepared with zinc oxide and hammerscale, as at Idria. The shaft-furnace feed is not sampled. The burnt rock is sampled in the morning and in the evening just before ore is drawn in the fine-ore furnaces. About 20 grams of this are used for an assay. The shaft furnace soot is very rich despite the poor grade of the ore treated by these furnaces; the ratio of free mercury to mercury in the soot is 1 to 3, while at the fine-ore furnaces only 17 to 20 per cent is recovered as free mercury. The pressed soot from the shaft furnace still contains 28 to 50 per cent mercury. The plant (which is working with a loss of 15 to 20 per cent) produced 1200 flasks during 1912, including 2500 kg. of mercury from the shaft furnace. The cost of production was 150 lira ($29.15) per flask. Sixty-eight men were employed in the mine and sixteen in the metallurgical plant.

Modern Spirek Furnaces and Condensers at Morone

The ore deposits of Morone lie in the nummulitic limestone and at the contact of limestone and shale. The ores, which average 1 per cent mercury, are therefore very argillaceous. Because of the great quantity of water which aids the rock disintegration, a considerable volume of gas is evolved. The run-of-mine ore contains between 15 and 20 per cent moisture.

Since this plant was erected only a few years ago, Spirek's successor, following the fundamental ideas of his uncle and teacher, was enabled to apply all of his experience in its construction. Since the method of operation of nearly all the quicksilver plants of Tuscany is based upon the experience of the two Spireks, it might not be out of place to discuss the results.

In the development and improvement of the fine-ore furnaces it became manifest that the 24-ton furnaces, which use 12 per cent by weight of the input of fuel, are economical where beachwood is available. Other varieties of wood, such as oak, chestnut or fir, are not as suitable for this size of furnace because of the shorter flame, which does not suffice to completely burn the ore. With the 6-ton furnaces the ratio of ore to fuel is the same. Even though they necessitate more labor as com-

pared with the larger furnaces, they are very popular for high-grade ore and pressed soot, as complete roasting is more readily obtainable in them. The 12-ton furnace burns only 10.2 per cent of any kind of wood; the roast is complete, so that it may be used to furnace all ores.

A coarser or granular feed allows the space between tiles to be a little larger than with the dusty feed, the flame can more easily penetrate the flues and, since the cinnabar on these ores is deposited superficially, it is more easily and completely sublimated; this allows 26 tons to be treated in the 24-ton furnace without increasing the loss. With dusty or argillaceous ores the space between tiles is only 35 mm. (Abbadia San Salvatore and Morone 35 mm., Siele 30). Since these latter ores are generally richer, the slightly lessened tonnage is not very noticeable. It would pay to determine the degree to which the roasting must be carried so that the value of mercury driven off at the last is still slightly greater than the amount of fuel needed to drive it off, as it is possible that in current practice at Monte Amiata too much time and heat are used to extract the last small quantities. The upper row of inclined plates in the furnace is made of cast iron; in Siele the second last row has also been made of cast iron to prevent damage when charging. These upper rows of tile serve to seal the furnace charge, preheat and dry the charged material and are not themselves heated. The two lower rows of tile serve to preheat the air for combustion, and are not heated either. With the 12-ton furnaces the draw doors are placed along the short side of the furnace with the fire box, so that the first row of tile will be more evenly heated, while with the 24-ton furnaces the draw doors are situated on the long side of the furnace. The exit pipe is made of cast iron 4.5 meters long, as is also the first descending leg of the condenser. The flange connections of these pipes, packed with asbestos and red lead, have proven superior to sleeve couplings.

Condensers of Furnaces

A 24-ton furnace has ten parallel condenser lines, a 12-ton furnace has five, and the small 6-ton furnace has three. The large furnace has two small, separate condensers to draw off the moisture and charge gases from the upper two rows of tile[6]. The two smaller furnaces are built with one such separate condenser. Three wooden soot-boxes of cedar, into which the U-pipes of the condensers dip, are arranged perpendicularly to the direction of gas flow. More than three of these condenser units are not necessary; flues and chambers of a large cross section, which reduces the gas velocity, are more efficient for the collection of soot.

Up to a furnace capacity of 36 tons per day, one square meter of chamber cross-section is sufficient, while above this capacity it must be correspondingly enlarged. The necessary draft of about 5 mm. of water is obtained with a Root blower. If the last inverted U of a condenser line shows a slight pressure when the cover is removed, the draft is considered correct. One damper is situated just before the exhauster and regulates the entire gas stream.

[6](Translator's note). The tile referred to are the tile shaped like an inverted V of the Cermak-Spirek furnace, often referred to as "gable tile."

The first and second soot boxes are cleaned once a month, the third every three months; the cleaned mercury is drawn every fourteen days. The floor of the plant is cemented and has a network of gutters to catch any scattered mercury. Soot from different localities is pressed separately, as by doing this it is thought that a better extraction is obtained. The pressed soot retains about 15 to 20 per cent mercury. The soot from the hot part of the iron exit pipes is poor and so dry that water must be added to it so that the quicksilver can be pressed out. Soot from the first box contains 80 to 85 per cent mercury, soot from the second box about 70 per cent, and that from the third 45 per cent. In the first chamber the soot contains 30 per cent, and this soot is also sent to the soot press. Poorer soot is mixed an equal part of ore and charged again. One man can work out 30 flasks of quicksilver in an eight-hour shift. The empty bottles, which are numbered and weigh 4.5, 4.6 or 5.5, or a maximum of 6 kg., are weighed before filling, as is also the mercury; the filled bottles are again weighed.

The reduction plant of the Morone lies on a terraced slope about 500 meters from the adit mouth. In summer the ores are sun-dried, in winter they are dried on drying floors to a 4 per cent moisture content. The clay is cobbed from the limestone pieces, and the latter are hand-dressed to the desired size. The clay rock is fed into crushers, the product of which—ore containing 1 to 1.2 per cent mercury—goes without exception to two 12-ton fine-ore furnaces. The lump ore containing 0.3 per cent mercury is burned in two Spirek shaft furnaces, which are iron-sheathed, as was customary with the Caillaux furnaces in use forty years ago in this district. The work is carried on in three eight-hour shifts; two men per shift are needed to operate one fine-ore furnace and one shaft furnace. Since the material charged at this plant is fairly dusty, all three soot boxes are cleaned monthly, the first chamber being cleaned every three months. The mine employs 135 men, the metallurgical plant 45. The average monthly production of the last year was 200 flasks and this year has been increased to 350 flasks, so that the year 1913 may show a total production of 114 metric tons of mercury. In view of the high-grade ore the plant loss is estimated at only 10 per cent of the input.

Smaller Plants in Tuscany

The plant at Bagni San Filippo, Petrineri, treats its ores which contain 0.4 to 0.5 per cent mercury in two 12-ton furnaces and one twin shaft furnace, after they have been dried from a high percentage of water, in a manner similar to that employed at Morone. Thus far the financial aspect of the venture, in which 110 workmen produce 60 flasks of quicksilver per month, was not very promising. Recently gas exhalations encountered in the mine give rise to the hope that the primary ore body, which has not thus far been located, will soon be encountered.

The smallest plant is that of the Monte Buono mine, which treats its ore in a 24-ton fine-ore furnace. The ore is a sandstone impregnated with cinnabar running 0.2 to 0.3 per cent mercury. It is sufficiently dried by handling, and being a somewhat decomposed rock, is crushed with wooden mallets. The soot is mixed with

lime and treated in retorts to prevent the formation of soot from the soot. During the summer, the plant, which otherwise produces 40 flasks per month, is closed because the 80 miners are really farmers and work on their farms during this time.

The occurrences of antimony-quicksilver ores of the Maremma grossetana, which extends from Selvena over San Martino and Capita in a southwest direction to the Tyrrhenian Ocean, are closely associated with the above cinnabar ore deposits. The mine of Selvena, which is producing black bituminous lower Jurassic limestones impregnated with cinnabar, antimony-glance and pyrite, has been abandoned. The ores of San Martino, a red-colored, brown iron ore impregnated with cinnabar, occurring in thin Eocene strata, impregnated with antimony-glance, have no commercial importance. The same is true of the old mine near Capita at Capalbio, the ore deposit of which lies in the Rhatkalk near the contact of the Eocene.

Colloids and Flotation

United States Bureau of Mines Technical Paper 200, "Colloids and Flotation," shows the application of certain facts of colloidal chemistry and physics to practical flotation operations. Some of the unexplainable troubles in the flotation plant can probably be explained by the facts that have developed in the study of colloids. They draw attention to the fact that at times some sulphides are not wetted by water and under other conditions are wetted. The last case is, of course, an abnormal one, and when this condition obtains flotation is impossible. It can probably be explained by the phenomena of adsorption. The adsorption phenomena are an effect due to surface energy. Surface energy is a product of surface tension multiplied by area. Therefore, the adsorption phenomena are affected by any factor that tends to increase or reduce surface tension. The surface energy and adsorption effects for solids can only be proven by analogy of the action of liquids and gases.

Willard Gibbs developed a thermo-dynamical formula to show that adsorption is due to a concentration of molecules in the surface of solids or liquids and that it can be either positive or negative. Therefore any material that will give negative adsorption for water, say, would probably give positive adsorption for gases. Impurities in solution tend to upset surface energy conditions and would cause positive adsorption for gases to be changed to negative adsorption for them. As adsorption is manifest by wetting or non-wetting in our case, it is seen that under certain conditions some sulphides can be wetted by water and others not.

In dealing with a solid, water and oil phase the action of adsorption toward the solid will be the algebraic sum of the surface energies of all the material entering into the sphere of action. Hence any substance that tends to upset the surface tension or energy of any one of the three or four phases involved would tend to change the resultant surface energies of all of them and hence upset the conditions that have been established for adsorption of either the water or the gases involved, as the case might be. Therefore, it can be seen that any impurities in solution in the water would tend to affect this algebraic sum and hence upset the necessary equilibrium necessary to float the sulphides from the pulp. Also, as the surface energy is the product of the surface energy multiplied by the area, the presence of any material having very largely developed surfaces which is of course principally colloidal would tend to upset the equilibrium and hence flotation.

As size is such an important factor, it is plain too that the oil can be too much emulsified. In fact, when the oil is in an extremely colloidal condition it is impossible to get good flotation results. The fact that the same materials which tend to throw the oils out of emulsion are substances that benefit flotation is a proof of this statement.

A practical illustration of some of these things is the case at Inspiration, where it was found to be impossible to float the copper sulphide from the gangue containing large amounts of decomposed material such as koaline, which is of course a colloid. No trouble was encountered, however, in locating the hard undecomposed ore.

There are several different types of colloids, but the most important are the so-called irreversible and reversible colloids. The irreversible colloids are those that are most liable to be present in ore pulps, being iron, aluminium hydroxide, etc. They are called irreversible because it is impossible to put them back in colloidal condition after having once flocculated them by means of an electrolyte.

The reversible colloids are those that can be put back into colloidal condition by simply shaking up after flocculation. They are very inactive toward electrolytes. Among the reversible colloids might be mentioned aqueous solutions of gelatin, glue, gum, tungstic acid and molybdic acid. These materials cause great trouble in flotation and are very difficult to remove.

From this short discussion several conclusions might be drawn. Among them are that colloids interfere greatly with flotation and that in order to overcome the difficulty they must be removed. There are several ways of doing this, among them being preliminary heating of the ore, washing the ore or flocculating it by means of electrolytes. These are, of course, the means of removing irreversible colloids. As far as is known, there is no way at present of overcoming the difficulty due to productive colloids or reversible ones.

The Graselli Prize

At the meeting of the N. Y. section of the Society of Chemical Industry, on Oct. 25, the honorary secretary, Major Allen Rogers, announced an annual prize in the form of a medal to be given to the author of the paper of the greatest general interest and value presented at any meeting of the New York section of the society during the year. The donor of the medal is the Graselli Chemical Co. and it is to be known as the Graselli prize.

Ramsay Memorial Fund

More than $3,000 had been contributed to the Ramsay Memorial Fund in the United States up to Nov. 1. It is hoped that the American subscription may reach $10,000 by Jan. 1. Checks should be made payable and sent to the Ramsay Memorial Fund Committee, W. J. Matheson, treasurer, 2 Burling Slip, New York City.

Synopsis of Recent Chemical and Metallurgical Literature

Magnesium Lead Alloys.—In a paper read by MR. E. A. ASHCROFT before the Faraday Society at the London meeting in July, 1918, the disintegration phenomenon herein noted, and any prospect there may be of technical utilization of such alloys and their properties, are all based on the accidental discovery made in the course of some other researches of very remarkable properties which are possessed by alloys of metals of the magnesium type with metals of the lead type. The alloys of magnesium with lead—for instance, an alloy of 15 per cent magnesium with 85 per cent lead—will rapidly and completely oxidize in the cold if exposed to atmospheric oxygen and moisture, being then converted rapidly into a "jet-black" powder having the composition of magnesium hydrate and lead sub-oxide or its hydrate. The reaction is complete in a few hours. The water present up to this stage of the reaction does not take any part in the oxidation of the metals, and is not itself decomposed, but combines with the oxide of magnesium and the sub-oxide of lead to produce hydrates, the oxygen absorbed by the metals being obtained from the atmosphere.

For atmospheric oxidation, alloys of 15 per cent Mg are preferable to those of higher content, as the richer alloys (*e.g.*, an alloy of 35 per cent Mg and upward) will not oxidize readily in the cold. By use of this reaction, if sufficient of the alloy be exposed to combine with all the oxygen in any confined space, every trace of oxygen may be removed from any gaseous mixture containing it. It seems therefore possible that such alloys might find useful application both in the laboratory and also in small commercial operations for manufacturing nitrogen from the air and for removing oxygen from any gaseous mixture in the cold. Such a process might, for instance, economically take the place of the last rectifying tower at present used in the large-scale manufacture of nitrogen for conversion to ammonia cyanides or nitrates by liquefaction and fractional distillation of air.

But one may also utilize these magnesium-lead or like alloys for the production of pure hydrogen gas for aircraft or other purposes. For this purpose alloys richer in Mg may be employed, and 35 per cent is a convenient strength. It is only necessary to boil such alloys in water, when reaction takes place as follows:

(*a*) $Mg + H_2O = MgO + H_2$;

(*b*) $2Pb + H_2O = Pb_2O + H_2$.

The reaction (*a*) takes place briskly. The lesser reaction (*b*), however, under these conditions proceeds only very slowly, and if it is required to render it rapid and complete, it is preferable to digest the alloy under a steam pressure of 100 lb. to the square inch and a corresponding temperature of about 150 deg. C., when the lead will be completely oxidized to PbO, and the theoretical quantity of hydrogen liberated. The hydrogen may be drawn off from the pressure vessel with the steam and collected. From the mixture of hydrates or oxides of magnesium and lead resulting from the reactions also numerous useful products may be obtained.

The hydrates especially are extremely reactive substances, and are obtained in most suitable condition for subsequent further reactions. For many purposes the mixture of hydrates of lead and magnesium may be used without separation. But separation of the magnesium oxide is also easy if required. As an example of possible utility of the residues, the manufacture may be cited of lead peroxide, which according to the known reaction may be easily produced by passing chlorine gas into water in which is suspended a mixture of PbO_2H_2 and MgO_2H_2 in molecular proportions. The oxidized alloys may also be employed for the preparation of other lead salts or compounds, and would seem to form a most convenient base for this purpose. For instance, a very fine quality of basic lead carbonate (white lead) may be obtained very easily by acting on the lead hydrate with carbonic acid, either with or without separation of the magnesia. The white magnesium carbonate would probably be no detriment to this product as a pigment, but rather the reverse, as it seems to improve its covering and its drying properties. Litharge and minium may also be obtained from the material very readily, and, if desired, of great purity and excellent physical properties, by simple processes.

The mixture of oxides resulting from the oxidation of these alloys may therefore form a valuable starting-point for other manufactures, and in some instances (such as lead peroxide and white lead) it would seem probable that its use may be economical and may constitute substantial improvements in the known processes of manufacture of these products.

To prepare the alloys of magnesium and lead any convenient method may be employed; for instance, magnesium and lead may be readily fused together under a cover to a temperature of 700 to 800 deg. C., and after mixing thoroughly, cooled out of contact with the air, when complete alloy will be found to have taken place, and the product can be readily broken up. Or magnesium may be precipitated from its salts into the lead by employing alkali metals or alkali metal alloys.

But to render the production of such alloys specially economical it is proposed to electrolyze anhydrous magnesium chloride (which is now being produced commercially and very economically by the process for which British Letters Patent 12,873 and 13,259, both of 1916, were granted) over a cathode of molten lead. In such manufactures the electric energy required is the chief item of cost, and consumption is only 2,000 kilowatt hours per ton of 15 per cent alloy. Thus where electricity is very cheap these alloys can be obtained practically at nearly the same cost per ton as metallic lead, and the resulting useful products and effects may be obtained with a considerable degree of economy.

These alloys furthermore possess the valuable feature that they may be produced where electric energy is cheap, and then transported cheaply in sealed cans and utilized at any remote situation. Thus, for instance, as a source of hydrogen or nitrogen for aircraft or for localized manufactures of ammonia or nitric acid, the cost of transport of the alloy would be only a small fraction of the equivalent cost of transport of the products, or of an equivalent quantity of gases in cylinders. For example, the weight of material transport required to

produce a given quantity of hydrogen at any remote situation will be only as 1 to 6 and of nitrogen as 1 to 10, when compared to the transport of cylinder gases. Also the wear and tear and capital sunk in cylinders and the cost of compression are all obviated. These are very substantial advantages to set against the cost of the alloys, but to them must also be added that in most instances the solid products of decomposition of the alloys are as valuable as (and sometimes much more valuable than) the alloys, so that the gases are obtained as by-products and substantially free of cost.

Dehydrogenation of Petroleum Oils.—Dr. A. S. RAMAGE in the *Canadian Chemical Journal* of August, 1918, gives an account of a commercial method of making volatile motor oils from the high boiling point paraffines without decarbonization, part of which we quote:

In my process my endeavor has been not to crack the oil, but to obtain a definite chemical reaction, namely—the dehydrogenation of the paraffine to the olefine. In other words, our product is a motor fuel which practically is 95 per cent olefine—the other 5 per cent being further unsaturated products. Water is always produced in dehydrogenation, and is condensed and separated from the fuel in the receiving tank. The reaction can be carried as far as the aromatic series, depending entirely upon the temperature and length of tube through which the vapors are passed. The reaction is as follows:

Paraffines Olefines
$$C_nH_{2n+2} + O = C_nH_{2n} + H_2O$$
Olefines Acetylenes
$$C_nH_{2n} + O = C_nH_{2n-2} + H_2O$$
Acetylenes Terpins
$$C_nH_{2n-2} + O = C_nH_{2n-4} + H_2O$$
Terpins Aromatics
$$C_nH_{2n-4} + O = C_nH_{2n-6} + H_2O$$

The vapors are passed over heated iron oxide Fe_2O_3. At the temperature for motor fuels of 620 deg. C. the oxygen is taken up with the reduction to the oxide FeO, at which stage we stop the action, steam out the oils remaining in the oxide for five minutes and re-oxidize with a current of air for fifteen minutes. We are very careful not to allow the reduction to go beyond FeO, because if metallic iron is formed, cracking immediately takes place with deposition of carbon. The action of dehydrogenation is endothermic, whereas the reoxidization is of course exothermic. The period of dehydrogenation lasts for three hours in practice and the revivification one-half hour.

Our first production was in a laboratory tube, electrically heated, 2 feet long, followed by a tube 8 inches in diameter, 4 feet long—then by a tube 10 feet long 8 inches diameter. Our conversion of the original oil would always run 36 per cent, once run through the tube. Since then we have extended the tube to 24 feet and our conversion averages 90 per cent of the original oil, and the recovery 94 to 95 per cent. No carbon has been produced. After steady running of eight months, the iron oxide was removed from the tube and not a trace of carbon was found in it.

The works were built at River Rouge on a practical scale. After several fires, it was burned down and a new works has been erected at Ecorse.

Furnaces containing tubes 8 inches in diameter and 22 feet long are now adopted as the best length and diameter with the feed of ten gallons per hour per tube. For a motor fuel to correspond with the present ordinance for gasoline, a temperature of 600 to 620 deg. C. is kept in the lower half of the tube. The waste heat from the oil burners heating the lower half of the muffle is led off at the upper end of the furnace, giving a temperature of 400 deg. at the upper end where the oil enters to 600 deg. where the vapors issue. We have found that by this progressive heating of the tube the product is not scorched and comes out of the condensers a deep straw color, whereas the passing of the oil or vapors immediately into 600 deg. C. causes the product to become dark and contain some tar. Progressive heating is one of the features of the process. A simple distillation of the condensate with 1 per cent fuller's earth is sufficient to refine the spirit. If we raise the temperature to 650 deg., we obtain a product running as high as 50 per cent under 120 deg. C. and at 680 deg. C. practically all of our product comes over with an end point between 120 and 130 deg. C. I mention this fact because of its application to not only the aëroplane industry but the production of low boiling olefines as a starting point in the organic chemical field.

It is perfectly feasible and does not add materially to the cost to obtain 80 per cent of the original oil with an end point of 45 deg. C. being composed of amylene and low boiling point olefines. One particular point about olefines is the wonderful solubility of ethylene in them. Ethylene is produced in quantity when we are running to obtain very low boiling point spirits, and the gas is compressed and passed through the spirit under pressure of 100 pounds to the square inch. Fifteen times the volume of ethylene is absorbed, and the peculiar point is that after releasing the pressure the ethylene is not given off at normal temperature but seems to be held in some loose form of combination, because at between 40 and 50 deg. C. it begins to come off in great volume. The fact that this gas is dissolved in the motor fuel in such loose form connection as to be so readily given off probably accounts for the quickness with which this fuel ignites, even below zero.

Of more interest to chemists are the products obtained upon further dehydrogenation. Practical results have shown us that with the tube length of 50 feet, and a feed of ten gallons per hour, from 20 to 30 per cent toluol can be produced, not counting the other aromatics. In toluol production the upper end of the tube is kept at 400 and the lower end at 750 deg. C. In the conversion of xylol, $C_6H_4(CH_3)_2$, as high as 72 per cent has been obtained of the benzol-toluol fraction containing 30 per cent benzol; the balance toluol. In the separation of aromatics from olefines present the usual sulphuric-acid treatment is followed. I find, however, that this reaction which has always been used is very incorrect and not more than 20 per cent of olefine is reacted upon, the balance of the olefines being polymerized to high boiling point olefines. It can be seen by the simple dehydrogenation of the petroleum oils we are in a position to produce olefines, acetylenes, terpins and the aromatics, and from these bodies the alcohols and various organic products.

Recent Chemical and Metallurgical Patents

Universal Soap Dyes.—Fast on cotton, linen, wool, silk or mixtures.

Dyes for use in coloring textile fabrics in the household laundry have been long on the market. Recently new developments have been made in the manufacture of these materials, a description of which is found in the patents recently allowed to CHARLES C. HUFFMAN of Chicago, Ill. Browns from copper to chocolate shades; blues from baby to navy; reds through flesh pink, rose, salmon, orange, old rose, lavender and purple; yellows and greens, are all compounded from four prominent commercial coal tar dyes: aniline acid red, methylene blue, chrysoidin yellow and a direct black.

Mr. Hoffman states that his improved dye soap should not be confused with those in which the soap acts merely as a carrier or vehicle for the dye, as peculiar reactions take place between the dyes used and the soap, which give a different product than hitherto obtained. One of the important distinctions of the new dye compound is that it is alkali proof, irrespective of the prior basic, acid or neutral characteristics exhibited by the dye before combining with the soap.

A still further distinction is that these dyes are universal, that is, adaptable directly to either cotton, linen, wool, silk or mixtures thereof. The greatest advantage, however, is that temperature, time and concentration of the dye suds do not influence the depth of shade; therefore no special skill is required in matching pieces treated separately.

In producing forty-five pounds of soap dye, about twenty-five and one-half pounds of olive, soy bean, raisin, peanut, corn or any vegetable oil are saponified in the cold with thirteen and a quarter pounds of sodium hydroxide solution (sp.gr. 1.40 at 65 deg. F.). When the reaction is nearly complete, one gallon of boiling dye solution is added to the incompletely saponified oil soap emulsion. The heat of the reaction together with the heat supplied in the added boiling dye solution serves to raise the temperature of the mixture to approximately 122 deg. F., at which temperature the dye reacts with the free sodium hydroxide, forming a sodium salt of the dye acid with the elimination of a molecule of water. The formula of the resulting dye has not been determined; none of the reactions characteristic of the dye acid remain, however, so that a new compound is thought to exist.

In ordinary solutions, crysoidin yellow will precipitate aniline acid red and the latter will throw methylene blue out of its solution. In making browns by this process, all three of these dyes exist in solution simultaneously. A medium shade of brown is produced by adding to the emulsion a quart each successively of the following boiling dye solutions: 7½ oz. chrysoidin yellow, 7½ oz. aniline acid red, 5 oz. direct black and ½ oz. methylene blue. Greens are prepared by adding 2 quarts of boiling chrysoidin yellow solution followed by a like amount of methylene blue. The intensity of the various shades depends on the amounts of dye acids compounded into the soap emulsion and the colors on their relative proportions, so that color matching will not be left to the skill of the user. (July 30, 1918; 1,274,046-047-048-049.)

Separation of Alunite from Gangue.—CARL F. HAGEDORN of Chicago notes that the specific gravity of alunite and its associated rhyolitic gangue is so nearly equal as to prevent gravity concentration. He therefore recommends a preliminary calcination of the material, crushed to ¼-inch, in a rotary kiln operating at about 1000 deg. C. The kiln and temperature should be so adjusted that practically all of the SO_3 is driven off during the two or three hours the particles are in the kiln. High temperatures are to be avoided, since they volatilize potash. The inventor specifies that the fuel shall be oil, gas or other non-silica bearing material, noting the fact that the fine ash from pulverized coal adheres to the calcine and fluxes the various constituents in such a way that further separation is retarded. After calcination the gangue material is of its original texture but the alunite has been disintegrated so that separation in many known ways is easy. Simple screening is suggested for the separation of the fine alumina and potash from the coarser particles of rhyolite. A particularly advantageous method of separating the potash consists in digesting the calcined materials in an autoclave at about 60 pounds pressure and a temperature high enough so that the contents may not cool below 90 deg. C. until after they have been filtered. Only sufficient water is introduced to take the K_2O in saturated solution at 90 deg. C. After digestion the sludge is separated from its coarser and heavier particles of gangue in a V-box or dewatering cone, the overflow of which contains the finest and purest alumina in suspension and the potash in solution. (1,253,590 and 1,253,591; assigned to Mineral Products Corporation; Jan. 15, 1918.)

Aluminates from Alunite.—P. R. HERSHMAN of Chicago, Ill., has already patented (1,191,104) a method of obtaining soluble potassium aluminate from alunite. He has now discovered that practically complete extraction of the potassium may be had by the following process: Mix 30 parts of calcium oxide with 100 parts of pulverized alunite, heat the mass in a muffle to 1000 deg. C. in the presence of steam, when a water soluble compound corresponding to the formula $K_2O.2Al_2O_3$ is formed. This is removed by leaching, and the potash-free residue containing about 60 per cent of the alumina may be further treated as follows: Barium sulphate and calcium oxide are each added to the residue in molecular proportions to the alumina contained, and the mixture heated in a muffle furnace for about three hours in the presence of superheated steam. The greater part of the barium and aluminium forms a soluble barium aluminate which may be extracted with hot water. The compound is of value as a ready source of pure alumina.

Barium aluminates of the formula $BaO.Al_2O_3$ or $2BaO.Al_2O_3$ may also be made of the residue from the sodium aluminate leach by mixing with barytes, together with considerably more carbon than is required to effect the reduction of the latter to the sulphide. The mass is pulverized to 100 mesh and is heated for four hours at 1050 deg. C. in a muffle furnace through

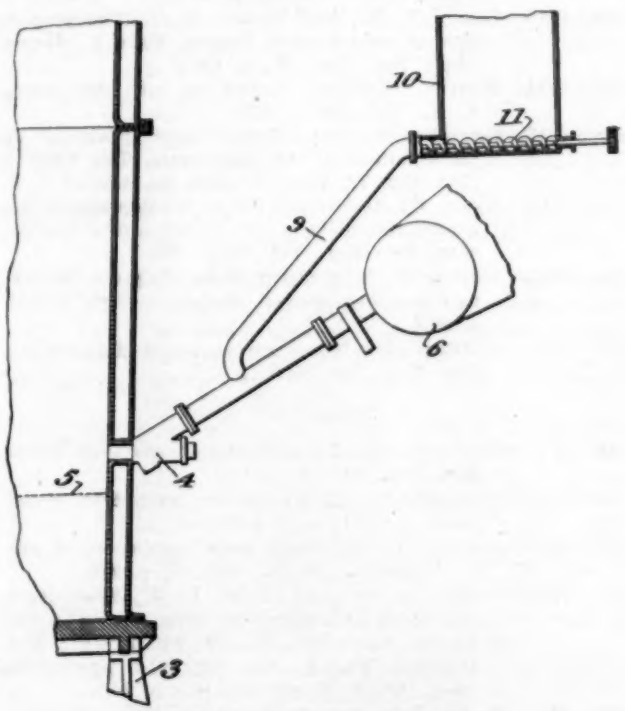
which is passed a slow current of reducing gas and steam. The excess carbon, steam and reducing gas maintain an atmosphere containing more or less CO, which is of use in preventing the decomposition of the barium aluminate by CO_2. During the operation elemental sulphur is driven off, which may be collected by known methods. (1,240,571-2 and 8; assigned to Armour Fertilizer Works; Sept. 18, 1917.)

Pure Alumina from Alunite.—HOWARD SPENCE and W. B. LLEWELLYN of Manchester, England, note that the residue from leached calcined alunite contains so many impurities, such as iron and silica, as to render it unfit for use in metal or abrasive manufacture without further purification. They therefore propose to ignite the alunite in such a manner as to produce maximum solubility, to pulverize the calcine and to hydrate the mass in the cold for several weeks in liquor from a previous operation. The hydrated material is then agitated for a few hours in a series of closed vessels during the passage of SO_2, maintaining a temperature of 40 deg. C. The solution is now tested for SO_4 ion, and any excess over 0.9 mols Al_2O_3 is removed by the addition of the proper amount of lime. If there remains any excess sulphate the precipitated aluminium will contain basic double alkali aluminium sulphate and considerable alumina will remain in solution. After filtration, the clear liquor is heated out of contact with air, the SO_2 driven off is re-used, and over 90 per cent of the alumina is thrown down as a granular basic sulphate which filters easily. Practically all of the iron remains in the solution if air has been properly excluded. The precipitation is best effected in dilute solution containing about 5 per cent Al_2O_3 to prevent the formation of double salts. The basic precipitate contains about 30 per cent Al_2O_3, and may be converted into the latter by ignition. (1,256,605; Feb. 19, 1918.)

Potassium Nitrate from Alunite.—H. J. DETWILLER of Allentown, Pa., proposes to digest powdered alunite with boiling nitric acid, taking into solution all the potassium and aluminium as nitrates and sulphates. Fine silica remaining may be removed by filtration and marketed for the manufacture of water glass or polishes. The aluminium in the filtrate is precipitated by the addition of KOH in quantitative amounts under constant agitation, and the aluminium hydrate removed by filtration. This is ignited into Al_2O_3 and is ready for use in the manufacture of metal, alums or other chemical products. The clear liquor is agitated and boiled with a quantitative amount of powdered barium carbonate to remove the sulphate radicle. The precipitated barium sulphate is the well-known blanc fixe of commerce, of extended use as a pigment and size. Carbonic acid is now removed by the addition of nitric acid, and the remaining solution, containing only potassium nitrate, crystallized to saltpeter, used in explosive manufacture, fertilizers and chemical industry. (1,274,145; July 30, 1918.)

Continuous Roaster-Extractor.—WM. E. GREENAWALT of Denver, Colo., patents a process of roasting and extraction, where the roasting is done in a vertical shaft of considerable height and with closed top. Across the bottom are a series of pipes perforated with fine holes, through which air and any other gas desired to participate in the reactions are introduced. The roasted ore is passed between the tuyere pipes into a downward extension of the shaft submerged in a tank of water or other solvent, and is fed into the solution gradually by a mechanical feeder. A drag conveyor removes the leached ore, while the overflow removes fines and slimes in suspension in the solution. The method applies blast roasting so that the heat in the calcine is utilized to facilitate leaching, and losses of dusting are overcome. (1,218,996; Mar. 13, 1917.)

Introducing Fuel Through Tuyeres.—THOS. W. CAVERS of Copperhill, Tenn., patents the method of introducing all or part of the fuel needed in matte smelting in blast furnaces through the tuyeres, according to the diagram shown herewith. The bustle pipe 6 delivers air under pressure through the tuyere 4 into the furnace slightly above the slag line 5. Fine coal is discharged simultaneously from hopper 10 by means of



TUYERE AND FEEDING APPLIANCE

screw conveyor 11 and pipe 9. He finds that in working a certain sulphide charge semi-pyritically it has been necessary to add approximately 6 per cent coke to the ore and flux at the top of the furnace column. Except when starting the furnace, coke additions may entirely be supplanted in the new practice by approximately four per cent of fine coal, of inferior bituminous grade. Pulverization is not needed; the pieces of coal should be merely sufficient to allow uniform delivery without danger of clogging the piping. Sulphide ores, plus necessary fluxes, may also be introduced in this manner; fuel oil may be utilized instead of coal if it is more readily obtainable. In this manner the fuel is burned very close to the focus where it is needed, the focus is substantially lowered, and the top of the ore column is much cooler. The introduction of all or part of the fuel in the smelting of oxidized ores to a matte is also feasible; an oxidizing atmosphere must be maintained in the smelting zone, to prevent the formation of metallic "sows." (1,259,467; Mar. 12, 1918.)

Aluminium and Its Light Alloys—VI Bibliography (b)

By Paul D. Merica

THE following continuation of the Bureau bibliography on aluminium and its light alloys is the supplement to the very comprehensive one assembled by the library of the United Engineering Societies and presented to the Bureau by Professor Zay Jeffries.

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Book Reviews

HANDBOOK OF CHEMISTRY AND PHYSICS. Fifth Edition, duodecimo (11 x 16 cm.), 414 pages; price $2.00. Compiled and sold by The Chemical Rubber Company, Cleveland, Ohio, U. S. A.

The company employed Dr. W. R. Veazey and Mr. C. D. Hodgman, of the Case School of Applied Science, to select the data in their first edition; Prof. M. F. Coolbaugh of the same institution assisted Mr. Hodgman in the present revision. A large number of the tables have been revised, and numerous new ones added.

There is an immense amount of useful information between the covers of this book, and it is wonderful book-value for the money—as book prices go. But there is also a regrettable amount of misinformation mixed in with the good, a deplorable tendency to prepetuate ancient and honorable mistakes of earlier tables, and an exasperating absence of many well-known data. All the instances justifying this criticism cannot be catalogued, but examples of them are the following: The heats of formation comprise only three pages in large type, giving only part of Thomsen's results, which date from somewhere in the last century; not a single thermochemical value determined in the last twenty-five years is given. Many of Thomsen's values have been improved upon and hundreds of thermochemical data obtained since Thomsen died, but thermochemistry expired with Thomsen, as far as this handbook is concerned; furthermore, not over 10 per cent of the really important data determined by Thomsen are quoted in it. In the tables of physical constants of inorganic compounds, the melting

points of cerium, chromium, silicon and titanium are omitted as though unknown, those of magnesium, manganese, molybdenum, palladium, strontium and tantalum are given wrongly, in some cases several hundred degrees in error; tungsten is said to melt "above 1900 deg.," whereas for at least five years it has been known to melt above 3000 deg. Much of the information in this important table is ten years old or more, and frequently unreliable, in the light of more recent determinations.

The general characteristics of the tables containing miscellaneous information are the absence of the most modern or most accurate data, and their incompleteness. We regret to see students and practical men fed such scientific husks, because it inevitably leads to sloppy pseudo-science, which we had hoped was diminishing. There are better and more accurate chemical and physical handbooks on the market. In such a situation, the reviewer's advice would be to get the best or none; do not waste money on a book containing some unreliable tables, while purporting to give the most reliable data known.

MINING ENGINEERS' HANDBOOK, *Robert Peele*, editor-in-chief. First edition; 2375 pages; 4½ x 7½; red fabricoid; illustrated. Price $5.00. New York: John Wiley & Sons.

The scope of this handbook is quite extensive, having besides the sections dealing with mineralogy, ore deposits, methods of prospecting, exploration and mining, and mining equipment, a good selection of civil, electrical and mechanical engineering subjects, economics and law. The staff of editors is very well chosen: mineralogy, A. J. Moses; geology and mineral deposits, J. F. Kemp; earth excavation, H. P. Gillette; explosives, Haskell, Holmes, La Motte and Le Maistre; rock excavation, H. P. Gillette; tunneling, Brunton-Davis; shaft-sinking in rock, H. L. Carr; shaft-sinking in alluvial soils, F. Donaldson; boring, A. F. Taggart; prospecting, development and exploitation of mineral deposits, J. F. McClelland; underground transport, E. C. Holden; hoisting plant, shaft pockets and ore bins, W. M. Weigel; drainage of mines, R. A. Norris; mine ventilation, F. E. Brackett; compressed air plant, R. T. Dana; electric power for mine service, G. R. Wood; surveying, Chas. B. Breed; underground surveying, Ed. K. Judd; mine geologic maps and models, R. H. Sales; mine organization and accounts, J. R. Findlay; cost of mining, J. R. Findlay; wages and welfare, E. K. Judd; mine air, hygiene and accidents, G. S. Rice; mining laws, H. V. Winchell; mine examination, valuations and reports, W. Y. Westervelt; aerial tramways and cableways, E. B. Durham; mechanical conveyers, L. De G. Moss; ore dressing, R. H. Richards; ore sampling, T. R. Woodbridge; assaying, E. J. Hall; testing of ores, J. E. Clennell; notes on selling, purchasing of ore, A. L. Walker; gold amalgamation and cyanidation, E. A. Dufoureq; preparation and storage of anthracite coal, P. Sterling; preparation and coking of bituminous coal, H. M. Conner; mathematics and mechanics, C. H. Burnside; elements of hydraulics, J. K. Finch; engineering thermodynamics, E. D. Thurston; steam engines, boilers, pumps, turbines, gas engines, Parr, Thurston and Herrick; mechanical engineering, miscellany, Thomes and Parr; electrical engineering, W. I. Slichter; elements of structural design, J. K. Finch; general tables. While it has been customary to make engineering handbooks more or less dependent upon one another and to give thorough treatment in their limited field, the policy of this handbook is to furnish the mining engineer with a ready reference book on all subjects most likely to demand reference without regard to the other special handbooks he might be expected to have.

Personal

MAJOR SAMUEL AVERY, chief of the university relations branch of the Chemical Warfare Service, resigned his commission on Dec. 1 in order to resume his duties as chancellor of the University of Nebraska, Lincoln, Neb. This resignation has been permitted by the War Department at the request of the Board of Regents of the University of Nebraska. MAJOR VICTOR LENHER, in addition to his other duties in the relations section, now takes charge of the work relinquished.

MR. E. A. CAPPELEN SMITH has been elected vice-president of the Chile Exploration Co. and the Braden Copper Co.

MR. H. C. CHAPIN has severed his connection with the National Carbon Co., Cleveland, Ohio, to become associate professor of chemistry in Lafayette College, Easton, Pa.

MR. W. DEWEY COOKE, secretary and sales manager of the Southern Fertilizer & Chemical Co., Savannah, Ga., has been commissioned first lieutenant in the gas and flame division of the Chemical Warfare Service.

DR. HERMAN FLECK has been appointed consulting chemical engineer of the Chemical Production Co., operating at Owens Lake, Calif. He will continue to act as consulting engineer to the Chemical Products Co. of Denver, Colo.

MR. ELLWOOD HENDRICK, consulting editor of *Chemical and Metallurgical Engineering*, read a paper before the New York Section of the American Chemical Society at Buffalo on "Chemists in the Future" at the meeting held Nov. 20.

MR. JOHN MCCONNELL, metallurgical and engineering adviser of the United Alloy-Steel Corporation, Canton, Ohio, has resigned. He is now connected with the Interstate Iron and Steel Co., Chicago, Ill., where he has charge of producing alloy steels.

MR JOHN J. PORTER, first vice-president of the Security Lime & Cement Co., Hagerstown, Md., has been given a Government appointment as a dollar-a-year man. He is to act as potash expert for the Bureau of Mines and to help in working out plans for increased potash production.

MR. H. DEWITT SMITH has been appointed to a position with the Aircraft Production Board and will be stationed at Dayton, Ohio. He was formerly mine superintendent at the United Verde Copper Co., at Jerome, Ariz.

MR. HENRY P. WALTERS, recently in charge of the picric acid works of the Semet-Solvay Co., Split Rock, N. Y., has been selected to take charge of the new picric acid works now being erected for the Government at Grand Rapids, Mich.

Obituary

MR. HOWARD S. LEE died on Oct. 25 of influenza at Silverton, Col., at the age of 38. Ten years ago he became associated with the United States Mining, Smelting & Refining Co., and since then had managed several properties of that company. Recently he had been promoted to the position of assistant to the chief consulting engineer, with headquarters in San Francisco.

Current Market Reports

The Non-Ferrous Metal Market

Friday, Nov. 22.—The non-ferrous metal market has not excited any interest, the war prices still prevail except in the cases of tin, zinc and antimony, the former of which is expected to continue to decline.

Aluminium:—The Government prices on ingots 98 to 99 per cent Al are $660 a ton f.o.b. plant in 50-ton lots; $662 down to 15-ton lots; and $666 down to 1-ton lots, which prices will continue the remainder of the year. Prices per pound for small lots vary from 40c. to 45c.; sheet aluminium, 18 ga. and heavier, 42c.; powdered aluminium, 100 mesh, 70c.

Antimony:—The volume of sales is increasing at prices from 8¼c. to 8¾c. per pound.

Copper:—The price of $520 per ton for carload lots and 27.3c. per pound for small quantities was continued for another period at the conference held on Oct. 25 at Washington.

Copper sheets, hot rolled	lb.	$0.36 —	$0.37½
Copper sheets, cold rolled	lb.	.37 —	.38½
Copper bottoms	lb.	.44 —	.45½
Copper rods	lb.	.36 —	.37
Copper wire	lb.	.29½ —	.....
High brass wire	lb.	.28½ —	.29½
High brass sheets	lb.	.28½ —	.29½
High brass rods	lb.	.26½ —	.28½
Low brass wire	lb.	.32½ —	.34½
Low brass sheets	lb.	.32½ —	.34½
Low brass rods	lb.	.33½ —	.35½
Brazed brass tubing	lb.	.37 —	.39
Brazed bronze tubing	lb.	.42½ —	.44½
Seamless copper tubing	lb.	.41 —	.43
Seamless bronze tubing	lb.	.45 —	.46
Seamless brass tubing	lb.	.37½ —	.39½
Bronze (gold) powder	lb.	1.00 —	1.75

Lead:—The lead market is limited by selling restrictions, the supply being allocated by the Lead Committee. In carload lots at East St. Louis, the price is $155 per ton. In New York all speculative and traders' lead has disappeared. The Lead Committee apportions lead at 8.05c. to legitimate consumers.

Manganese:—The scale prices on page 629 of CHEMICAL & METALLURGICAL ENGINEERING, June 15, prevail; the highest price per unit being $1.35.

Silver:—Due to the flow of silver to Asia in payment for munitions and the greatly increasing industrial consumption in photography, motion picture reels and silverware, there is a shortage of silver even at the present government price of $1.01¼ per ounce.

Tin:—The Tin Committee of the American Iron and Steel Institute has not yet announced the official price on tin. No doubt an understanding will have to be had with the producers before a final statement can be made public and as they are all in distant foreign countries, considerable time will elapse in intercommunication, with the added possibilities that prices will not be legally fixed but adjusted by economic conditions as to demand. The market is dull at a price of 71c. per pound.

Tungsten:—The market is quiet, scheelite bringing as high as $25.50 per unit; wolframite, $23.00 and off grade ores as low as $17.00.

Zinc:—The spelter market is firm. East St. Louis is quoting $164 to $166 for November, $160 to $164 for December, $158 to $162 per ton for January. New York prices are from $170 to $174. Zinc dust, 13½c. to 16c. per pound. Sheet zinc, 15c. pound.

OTHER METALS

Bismuth	lb.	$3.50—	$3.65
Cadmium	lb.	1.50—	.....
Cobalt	lb.	2.50—	3.50
Magnesium	lb.	1.75—	2.10
Mercury	75 lb.	125.00—	.....
Mercury	lb.	1.95—	.....
Nickel	lb.	.40—	.43
Tungsten	lb.	34.00—	.....
Iridium	oz.	175.00—	.....
Palladium	oz.	135.00—	.....
Platinum	oz.	105.00—	.....

The Iron and Steel Market

The policy of the Government as to control of industry in connection with the transition from war time to peace time conditions has been quite fully outlined, but this does not determine the prospective course of the market. It is impossible to control trade completely, particularly when the control is intended to be exercised only for a limited period.

As to cancellation of contracts, the Government has adopted positively the policy of cancelling as rapidly as possible all orders for material that will not be needed, provided no work is being done upon the contracts, and of proceeding very slowly with the cancellation of contracts which are in course of being filled. On the one hand it is desired to save as much Government money as possible, while on the other hand it is desired to avoid idleness of plants and workmen.

As to limitations on the consumption of steel, placed to augment the supply of steel for war purposes, all restrictions have been practically removed, the earliest order being dated November 11, the day on which the armistice was declared, while other orders have followed in rapid succession.

As to restrictions upon producing operations, these have likewise been removed in very large part. The preference list is canceled, and all priority orders, whether individual or automatic, except those involving orders placed by the Navy Department, Fleet Corporation and railroad, telephone and telegraph companies. Inasmuch as priority orders merely prescribed the sequence in which orders should be filled when it was impossible to meet requisite delivery dates on all orders, a very moderate relaxation in the pressure for steel would automatically remove the necessity for priorities. The usual contract between producer and buyer is restored and mills will fill orders in accordance with their own appraisal of the needs of their customers.

As to prices, nothing has been done. The maximum limits prescribed to obtain deliveries through December 31 continue in force. As the quarterly price fixings in the trade have carried no reference to the duration of hostilities or the war, no question came up as to the continuance of the limits to December 31.

FUTURE OF PRICES

Under open trade conditions, the natural tendency of the iron and steel market upon the ending of the war has been well understood in all quarters. The common view has been that prices after the war would average below the controlled prices, but whether or not that were to be the case a declining market for a few months would naturally occur, because a full measure of demand would not at once develop. A large proportion of the buying of steel in normal times is for investment purposes. Technically speaking, almost every purchase of steel is an investment. Even the jobber invests, expecting to re-sell, but he may convert his investment into cash within 30 days in some instances. The automobile builder invests and sells the finished car in 60 days or a longer period. Other manufacturing consumers, particularly those making seasonable goods, require longer periods. The investor who builds a factory the product of which has no certain sale for a period of years may expect to amortize his investment in three to five years. Another can look farther ahead. A highway bridge may be a safe investment if it cannot be written off in less than 20 years. Each class of buyers, therefore, has his own period in which he concludes the steel market will not decline, if he is to buy at the time instead of waiting for a lower market. There can be no stable market for steel unless there is demand approximately sufficient to engage all productive capacity, and a demand of that size requires that the major portion of it be for investment purposes, hence there can be no stable market until the balance of probability is that the market will not decline for such a period as the future can be gaged.

The object of control, therefore, is double, to prevent a temporary demoralization in the market, and to develop what is the price level at which the control can be renounced and the market allowed to support itself at that level. To prevent demoralization the view was held that the War Industries Board should for a time fix minimum prices, as it has hitherto fixed maximum prices. The first thought was that possibly the Sherman law stood in the way. The second thought has been that irrespective of the Sherman law, the Government in attempting to fix minimum prices would be abandoning one of its cherished traditions, that "the Government has never bluffed." It has never issued an order unless it could punish violation. When maximum prices were set the Government was in position to commandeer plants and put them on Government orders exclusively if the owners refused to sell at fair prices. It has no means to punish a price cutter. At this writing the common thought is, then, that the War Industries Board will continue to set maximum prices and if the trade can hold together it will adhere to those prices as minimum likewise. As long as the prices are maximum also, they must be kept fairly high, or inroads may be made upon the co-operative spirit that has been so pronounced. As they are kept high, however, the readjustment to lower levels is impeded. Accordingly a thought is rising that when the time comes the War Industries Board will not fix prices for the period after December 31, or if it does will fix them at such levels that the market will be free to depart downwards from them.

Immediately upon the signing of the armistice and the removal of various restrictions upon the production and consumption of steel there developed an insistent demand which has given the market an appearance of strength, but in this case appearances are misleading. The demand is insistent where it exists, but it represents but a small fraction of the total buying public, and only those buyers who see their way clear to liquidate the investment in a very short time. The chief demand has, in fact, come from jobbers and automobile builders. Together these buyers do not normally absorb 20 per cent of the steel output. The jobbing demand is not for the purpose of accumulating stocks, but of securing such material as can be turned over quickly, chiefly before January 1, on which date it is desired inventories should be as low as possible. The automobile builders have some stocks of steel and during the next few months will not require much more than their normal weekly or monthly quota of steel.

This flash of demand will soon be over, and while other buyers will begin to appear in greater volume there will be on the other hand the gradual cancellation of war orders and the balance cannot be struck until real investment buying develops. That will probably require several months at least and thus the balance of probability is that there will be a period of lessened mill operations. When the market has once been established to the satisfaction of investors there is likely to be heavy demand for steel for a period of years. Even in the case of the government itself, while the desire is to avoid a slump in the market, the Railroad Administration is definitely committed to a policy of not making further purchases until steel prices are lower.

The Chemical Market

HEAVY CHEMICALS:—Trading in most all the items that come under this heading has developed a very conservative character and most consumers are averse to purchasing beyond their immediate requirements. Medicinal products again developed a firmer tone toward the latter part of the interval. General market quotations at the present, however, are considerably lower than previously indicated. Other products with but a few exceptions have had a downward tendency in price, particularly caustic soda, which has had a varied experience, though during the close a firmer market was in evidence, due to the possible lifting of the export restrictions which bring about buying interest for foreign account. Soda ash has also been neglected to a very noticeable extent and prices therefore have declined from 5c. to 10c. per hundred pounds, though conditions in the East continue to be somewhat more favorable than those in the West and Middle West.

Caustic Soda:—There is an unsteady undertone to the market at present, representing considerable diversity of opinion among traders as to the actual position of this product. Some holders who were offering at $3.85 early in the week have withdrawn their quotations, although up to the close some material was available in scattered lots at this figure. The more conservative operators are closely watching the trend of the market, in view of the possible developments that may take place at any moment. Advices from the West state prices were advanced for the solid material from 4c. per pound to $4.10 per hundred pounds, while in the East offerings were free at $3.90 per hundred pounds ex warehouse. The ground product is also liberal in supply, but there is no particular buying interest in evidence and prices remain firm at $5.10 per hundred pounds.

Soda Ash:—Conditions in this market have been somewhat easier for the past week and in most instances a decline in prices has been in evidence. Bag material during the latter period was generally quoted at from $2.45 to $2.50, while offerings of barrels were liberal at $2.85 and $2.90. Double bags from Western warehouses were quoted at $2.85. In Chicago single bags were held at $2.55 and barrels at $2.85.

Zinc Oxide:—Buyers have been showing very little interest in the item and the only trading noted is that which is passing through routine channels. There are no price changes reported and quotations generally range from 12½c. to 14c. per pound.

Yellow Prussiate of Soda:—There has been a continued depreciation in price for this material and quite frequently cheap lots are available, but despite this condition buyers are not attracted. Offerings of the product are made at from 36c. to 38c.

Bleaching Powder:—The government has removed all restrictions on the uses of chlorine and prices therefore have been on the decline. Quantities of the material were offered for bids, with sellers intimating that prices considerably below the market would be accepted, but there was no important trading. Prices for spot material range from 3½c. to 4c. and for that rolling 4c. to 4½c. was the asking price.

Potash Chrome Alum:—The market is reported to be quiet and the sales that are passing are consummated at the levels of 20c. to 21c., which continue to be the general quotations heard. Stocks are in fairly good supply and fully in proportion to the current call.

COAL TAR PRODUCTS:—Offerings of the products that come under this heading in most instances have developed to an easier position, but trading in general has been quiet during the past two weeks and that which is passing is only for immediate needs, with no disposition on the part of buyers to purchase ahead, owing to the uncertain conditions prevailing. The more conservative operators are just holding back, watching the trend of the market. No important price changes are noted in spite of the continued lull in the situation. However, where effected they have had a downward tendency. As soon as the contemplated cut in ammunition output is established, toluol will be available and the movement will open a wide field now practically closed.

Toluol:—Up to the present there is no reportable change of any importance in this market. The item is still under government control and there are no additional releases being granted. However, it is generally believed that all requisitions for December shipment will most likely be fulfilled. Some lots occasionally appear in the resale market at prices above those fixed by the government.

Xylol:—The restrictions relative to this item have been lifted and factors state they are in a position to consider business in this direction. Prices remain firm at the generally quoted range.

Formaldehyde:—The government ruling for this item as to prices is still in force. Stocks, however, are reported to be scarce and operators in the resale market are asking from 3c. to 4c. above these figures. Spot lots are difficult to locate and appear only in scattered lots.

Para Amidophenol:—Developments for this material have been such that many factors are out of the market owing to their sold up condition. However, available supplies are sufficient for current requirements, and those who have material to offer are still quoting prices at the same levels for both the base material and the H. C. L.

Dip Oil:—Manufacturers are in a position to fulfil all requirements of this product and prices are firm.

Phenol:—A rather uneasy undertone is prevailing in this market, as there are many manufacturers of this product who were kept busy on government requirements, and the more conservative operators are inclined to await developments before continuing to manufacture. Prices have declined from 2c. to 3c. per pound.

Benzol:—There has been a fairly active inquiry for this material and while its production has been plentiful and at the present writing a surplus of stocks is on hand, factors believe this product will again come to the front through its use for automobile propulsion, but this is only an opinion offered by some who are in close touch with the situation. Prices at the moment are firm for material in tank cars and in drums.

Orthotoluidine:—Offerings of this product are reported to be somewhat more liberal and a rather strong demand is in evidence, but trading is of a routine nature, with no important interest otherwise noted. Quotations generally heard remain at the same firm levels.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET NOV. 22, 1918

Acetic anhydride	lb.	1.60 —	1.85
Acetone	lb.	.25½ —	.25½
Acid, acetic, 28 per cent	cwt.	5.96 —	6.11
Acetic, 56 per cent	cwt.	10.76 —	10.87
Acetic, glacial, 99½ per cent., carboys	cwt.	19.00 —	19.20
Boric, crystals	lb.	.13½ —	.15
Citric, crystals	lb.	1.02 —	1.05
Hydrochloric, C. P	lb.	Nominal	
Hydrofluoric, 30 per cent, in barrels	lb.	.08 —	.08½
Lactic, 44 per cent	lb.	.15 —	.16
Lactic, 22 per cent	lb.	.06 —	.07
Molybdic, C. P	lb.	6.90 —	7.40
Nitric, 36 deg	lb.	Nominal	
Nitric, 42 deg	lb.	.08½ —	.10
Oxalic, crystals	lb.	.40 —	.43
Phosphoric, 47-50 per cent paste	lb.	.07½ —	.10
Phosphoric, ref. 50 per cent	lb.	.35 —	.40
Picric	lb.	.75 —	.85
Pyrogallic, resublimed	lb.	3.25 —	3.50
Sulphuric, 60 deg	ton	16.00 —	....
Sulphuric, 66 deg	ton	25.00 —	....
Sulphuric, oleum (Fuming), tank cars	ton	60.00 —	65.00
Tannic, U. S. P., bulk	lb.	1.40 —	1.50
Tartaric, crystals	lb.	.86 —	.95
Tungstic, per lb. of W	lb.	1.70 —	1.75
Alcohol, sugar cane, 188 proof	gal.	4.91 —	....
Alcohol, wood, 95 per cent	gal.	.91½ —	.92
Alcohol, denatured, 180 proof	gal.	.68 —	.69
Alum, ammonia lump	lb.	.06 —	.06½
Alum, chrome ammonium	lb.	.18 —	.19
Alum, chrome potassium	lb.	.20 —	.22
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.09½ —	.10
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03½ —	.04
Ammonia aqua, 26 deg., carboys	lb.	.08½ —	.09
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	.12 —	.13
Ammonium nitrate	lb.	(Fixed Price)	.15
Ammonium, sulphate domestic	lb.	.07½	.08
Amyl acetate	gal.	5.30 —	5.35
Arsenic, white	lb.	.09½ —	.13
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	80.00 —	90.00
Barium carbonate, 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	70.00 —	80.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.04½ —	.05
Barium nitrate	lb.	.12 —	.14
Barium peroxide, basis 70 per cent	lb.	.30 —	.32
Bleaching powder, 35 per cent chlorine	lb.	.03½ —	.04
Borax, crystals, sacks	lb.	.08½ —	.08½
Brimstone, crude	ton	65.00 —	70.00
Bromine, technical	lb.	.75 —	....
Calcium, acetate, crude	lb.	.04 —	.05
Calcium, carbide	lb.	.15 —	.17
Calcium chloride, 70-75 per cent, fused, lump	ton	22.00 —	24.00
Calcium peroxide	lb.	1.50 —	1.70
Calcium phosphate	lb.	.22 —	.23
Calcium sulphate, 98-99 per cent	lb.	.09 —	.09½
Carbon bisulphide	lb.	.08 —	.09
Carbon tetrachloride, drums	lb.	.45 —	.50
Carbonyl chloride (phosgene)	lb.	1.10 —	1.50
Caustic potash, 88-92 per cent	lb.	.67 —	.72
Caustic soda, 76 per cent	100 lb.	4.00 —	4.05
Chlorine, liquid	lb.	—	.07½
Cobalt oxide	lb.	1.60 —	1.65
Copperas	lb.	.02½ —	.02½
Copper carbonate	lb.	.30 —	.31
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09½ —	.09½
Cream of tartar, crystals	lb.	.68 —	.73
Epsom salt, bags, U.S.P	100 lb.	3.62½ —	3.90
Formaldehyde, 40 per cent	lb.	.16½ —	....
Glauber's salt	lb.	.02½ —	.03
Glycerine, bulk, C. P	lb.	.63 —	.65
Iodine, resublimed	lb.	4.25 —	4.30
Iron oxide	lb.	.13 —	.15
Lead acetate, white crystals	lb.	.17 —	.17½
Lead arsenate (Paste)	lb.	.15 —	.18
Lead nitrate	lb.	Nominal	
Litharge, American	lb.	.12 —	.14
Lithium carbonate	lb.	1.50 —	2.05
Magnesium carbonate, technical	lb.	.16 —	.17
Nickel salt, single	lb.	.14 —	.15
Nickel salt, double	lb.	.12 —	.13
Phosgene (see Carbonyl chloride)	lb.	1.10 —	1.50
Phosphorus, red	lb.	1.00 —	1.15
Phosphorus, yellow	lb.	1.10 —	1.20
Potassium bichromate	lb.	.45 —	.46
Potassium bromide granular	lb.	1.25 —	1.26
Potassium carbonate calcined, 85-90 per cent	lb.	.38 —	.40
Potassium chlorate, crystals	lb.	.38 —	.40
Potassium cyanide, 98-99 per cent	lb.	.60 —	.70
Potassium iodide	lb.	3.75 —	3.80
Potassium muriate, 80-85 p. c. basis of 80 p. c.	ton	300.00 —	350.00
Potassium nitrate	lb.	.27 —	.31
Potassium permanganate, U. S. P	lb.	1.75 —	1.85
Potassium prussiate, red	lb.	2.30 —	2.50
Potassium prussiate, yellow	lb.	.95 —	1.05
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal	
Rochelle salts	lb.	.47 —	.48
Salammoniac, gray gran	lb.	Nominal	
Salammoniac, white gran	lb.	.22 —	.24
Sal soda	100 lb.	1.40 —	1.65
Salt cake	ton	18.00 —	20.00
Silver cyanide, based on market price of silver	oz.	.... —	....
Silver nitrate	oz.	.63½ —	.64
Soda ash, 58 per cent, light, flat (bags)	100 lb.	2.50 —	....
Soda ash, 58 per cent, dense, flat	100 lb.	3.60 —	3.75
Sodium acetate	lb.	Nominal	
Sodium bicarbonate, domestic	lb.	.04 —	.04½
Sodium bicarbonate, English	lb.	.... —	....
Sodium bichromate	lb.	.21½ —	.22½
Sodium bisulphite, powd	lb.	.12 —	.14
Sodium chlorate	lb.	.25 —	.25½
Sodium cyanide	lb.	.30 —	.35
Sodium fluoride, commercial	lb.	.17 —	.18
Sodium hyposulphite	lb.	2.80 —	3.00
Sodium molybdate, per lb. of Mo	lb.	2.50 —	....
Sodium nitrate, 95 per cent	100 lb.	4.12 —	5.00
Sodium nitrite	lb.	.27 —	.30
Sodium peroxide	lb.	.35 —	.45
Sodium phosphate	lb.	.04 —	.04½
Sodium prussiate, yellow	lb.	.39 —	.40
Sodium silicate, liquid (60 deg.)	lb.	.03 —	.04
Sodium sulphide, 30 per cent, crystals	lb.	.06 —	.06½
Sodium sulphide, 60 per cent, fused	100 lb.	.10 —	.10½
Sodium sulphite	lb.	.05½ —	.06
Strontium nitrate	lb.	.25 —	.30
Sulphur chloride, drums	lb.	.07½ —	.09
Sulphur dioxide, liquid, in cylinders	lb.	.15 —	.40
Sulphur, flowers, sublimed	100 lb.	4.35 —	4.50
Sulphur, roll	100 lb.	3.70 —	3.85
Sulphur, crude	ton	65.00 —	70.00
Tin bichloride, 50 deg	lb.	.28 —	.29
Tin oxide	lb.	Nominal	
Zinc carbonate	lb.	.18 —	.20
Zinc chloride	lb.	.15 —	.15½
Zinc cyanide	lb.	Nominal	
Zinc dust, 350 mesh	lb.	.13½ —	.14
Zinc oxide, American process XX	lb.	.12½ —	.14
Zinc sulphate	lb.	.04½ —	.06½

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.22 —	.27
Benzol, 90 per cent	gal.	.25 —	....
Toluol, in tank cars	gal.	(Fixed Price)	1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)	1.55
Xylol, pure, water white	gal.	.45 —	.55
Solvent naphtha, water white	gal.	.18 —	.25
Solvent naphtha, crude, heavy	gal.	.12 —	.15
Creosote oil, 25 per cent	gal.	.45 —	.55
Dip oil, 20 per cent	gal.	.30 —	.32
Pitch, various grades	ton	8.00 —	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05 —	1.10
Carbolic acid, crude, 50 per cent	lb.	.60 —	.65
Carbolic acid, crude, 25 per cent	lb.	.35 —	.38
Cresol, U. S. P	lb.	.19 —	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00 —	1.10
Alpha naphthol, refined	lb.	1.50 —	1.60
Alpha naphthylamine	lb.	.55 —	.60
Aniline oil, drums extra	lb.	.28 —	.30
Aniline salts	lb.	.43 —	.45
Anthracene, 80 per cent	lb.	Nominal	
Benzaldehyde (f.f.c.)	lb.	4.25 —	4.50
Benzidine, base	lb.	1.75 —	1.85
Benzidine, sulphate	lb.	1.40 —	1.45
Benzoic acid, U. S. P	lb.	3.00 —	3.10
Benzoate of Soda, U. S. P	lb.	2.90 —	3.00
Benzyl chloride	lb.	2.45 —	2.50
Beta naphthol benzoate	lb.	10.00 —	12.00
Beta naphthol, sublimed	lb.	.75 —	.85
Beta naphthylamine, sublimed	lb.	2.65 —	....
Dichlor benzol	lb.	.15 —	.20
Diethylaniline	lb.	4.00 —	4.50
Dinitro benzol	lb.	.36 —	.38
Dinitrochlorbenzol	lb.	.40 —	.45
Dinitronaphthaline	lb.	.55 —	.60
Dinitrotoluol	lb.	.65 —	.75
Dinitrophenol	lb.	.45 —	.50
Dimethylaniline	lb.	.73 —	.75
Diphenylamine	lb.	1.00 —	1.10
H-acid	lb.	3.25 —	3.50
Metaphenylenediamine	lb.	1.85 —	2.05
Monochlorbenzol	lb.	.17 —	.20½
Naphthalene, flake	lb.	.09 —	....
Naphthalene, balls	lb.	.11 —	.12½
Naphthionic acid, crude	lb.	1.20 —	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00 —	1.10
Nitro naphthaline	lb.	.45 —	.50
Nitro toluol	lb.	.55 —	.60
Ortho-amidophenol	lb.	6.50 —	7.00
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-toluidine	lb.	1.00 —	1.10
Ortho-nitro-toluol	lb.	.75 —	.85
Para-amidophenol, base	lb.	4.50 —	....
Para-amidophenol, H. C. L	lb.	4.25 —	5.00
Para-dichlor-benzol	lb.	.15 —	.20
Paranitraniline	lb.	1.75 —	1.85
Para-nitro-toluol	lb.	1.50 —	1.60
Paraphenylenediamine	lb.	4.00 —	4.50
Para toluidine	lb.	2.25 —	2.50
Phthalic acid anhydride	lb.	4.25 —	5.00
Phenol, U. S. P	lb.	.40 —	.44
Resorcin, technical	lb.	4.50 —	5.00
Resorcin, pure	lb.	7.00 —	8.00
Salicylic acid	lb.	.85 —	....
Salol	lb.	1.50 —	2.00
Sulphanilic acid, crude	lb.	.31 —	.33
Toluidine	lb.	2.50 —	3.00
Toluidine-mixture	lb.	.85 —	.90

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00 —	....
Corning, Ohio	bbl.	2.85 —	....
Somerset, Ky	bbl.	2.60 —	....
Wooster, Ohio	bbl.	2.68 —	....
Indiana	bbl.	2.28 —	....
Illinois	bbl.	2.42 —	....
Oklahoma and Kansas	bbl.	2.25 —	....
Caddo, La., light	bbl.	2.25 —	....
Corsicana, Tex., light	bbl.	2.25 —	....
California	bbl.	1.24 —	1.57
Gulf Coast	bbl.	1.35 —	....
Mexican	bbl.	1.90 —	....

Fuel Oil

New York	gal.	.15 —	....
Philadelphia	gal.	.10½ —	....
Baltimore	gal.	.07½ —	.15½
Pittsburgh	gal.	.07½ —	.10
Texas	bbl.	1.85 —	2.35
Los Angeles	bbl.	1.65 —	....

Gasoline (Wholesale)

New York, motor	gal.	.24½	—	....
Gas machine	gal.	.41½	—	....
72-76 degrees	gal.	.33½	—	.39½
70-72 degrees	gal.	.32	—	.37½
67-70 degrees	gal.	.30½	—	.36½
Pittsburgh, motor	gal.	.25½	—	....
Chicago, motor	gal.	.22½	—	.23
Oklahoma, motor	gal.	.21½	—	....
San Francisco, motor	gal.	.20½	—	....

Paraffine Waxes

Crude, 103 to 105 deg. m.pt	lb.	.08½	—	.09
Crude, 118 to 120 deg. m.pt	lb.	.09½	—	.10
Crude, 124 to 126 deg. m.pt	lb.	.10	—	....
Refined, 120 deg. m.pt	lb.	.13½	—	....
Refined, 128 deg. m.pt	lb.	.14	—	....
Refined, 135 deg. m.pt	lb.	.16	—	.16½
Ozokerite, brown	lb.	.75	—	.80
Ozokerite, green	lb.	.85	—	.90

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.24	—	.25
Cylinder, light	gal.	.45	—	.50
Cylinder, dark	gal.	.39	—	.43
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, 0.903 sp. gr	gal.	.36	—	.38
Paraffine, 0.885 sp. gr	gal.	.26	—	.28

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	....
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	....
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.28	—	....
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	....
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	....
Wood creosote, ref., f.o.b. Florida	gal.	.31	—	....

Naval Stores

Rosin A-E barrel	280 lb.	16.60	—	16.80
Rosin F-I	280 lb.	16.75	—	17.10
Rosin K-N	280 lb.	17.65	—	18.10
Rosin WG-W	280 lb.	18.10	—	18.50
Spirits of turpentine	gal.	.85	—	.87
Wood turpentine, steam distilled	gal.	.62	—	.65
Wood turpentine, destructively distilled	gal.	.58	—	....
Pitch	bbl. 200 lb.	8.00	—	....
Tar, kiln dried	280 lb.	13.00	—	13.50
Retort tar	280 lb.	14.00	—	14.50
Rosin oil, first run	gal.	.80	—	....
Second run	gal.	.83	—	....
Third run	gal.	.88	—	....
Fourth run	gal.	.98	—	....

Vegetable Oils

Castor oil	lb.	.34	—	.38
China wood oil	lb.	.24½	—	.28
Cocoanut oil	lb.	.16½	—	.22
Corn oil	lb.	.18	—	....
Cottonseed oil, crude	lb.	.20	—	.22
Linseed oil, raw, cars	gal.	1.81	—	1.86
Olive oil	gal.	4.25	—	4.50
Peanut oil, crude	lb.	.18	—	.22
Soya bean oil, Manchuria	lb.	.17	—	.18½

Glues

Extra white	lb.	.36	—	.45
Cabinet	lb.	.31	—	.40
Brown foot stock	lb.	.18	—	.22
Fish glue, 50-gal. barrels	gal.	1.00	—	1.80

Miscellaneous Materials

Barytes, floated, white, foreign	ton	Nominal		
Barytes, floated, white, domestic	ton	33.00	—	36.00
Beeswax, white, pure	lb.	.63	—	.65
Beeswax, unbleached	lb.	.43	—	.48
Blanc fixe	lb.	.05½	—	....
Casein	lb.	.17½	—	.30
Ceylon graphite	lb.	.07½	—	.25
Chalk, light, precipitated, English	lb.	.04½	—	.06
China clay, imported, lump	ton	20.00	—	40.00
China clay, domestic, lump	ton	15.00	—	22.50
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f.o.b. mines	ton	28.00	—	40.00
Fluorspar, washed, powdered	ton	90.00	—	....
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Japan wax	lb.	.26	—	.27
Mexican graphite	ton	60.00	—	75.00
Madagascar graphite	lb.	.10	—	.15
Orange shellac	lb.	.72	—	.80
Pumice stone	lb.	.04	—	.08
Red lead, dry, carloads	100 lb.	.11½	—	.11¾
Soapstone	ton	15.00	—	25.00
Stearic acid, 120 deg. m.pt	lb.	.13	—	.14
Stearic acid, 140 deg. mpt	lb.	.18	—	.19
Talc, American, white	ton	20.00	—	40.00
White lead, dry	lb.	.09½	—	.10½

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	175.00	—	....
Chrome cement	net ton	75.00	—	....
Clay brick, first quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	50.00	—	60.00
Magnesia brick, 9x4½x2½	net ton	110.00	—	125.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y	ton	200.00	—	250.00
Ferrocerium	lb.	15.00	—	30.00
Ferrochromium, per lb. of Cr	lb.	.30	—	.40
Ferromanganese, domestic, 70 per cent basis	ton	250.00	—	....
Ferromanganese, English	ton	325.00	—	....
Spiegeleisen (16-18%)	ton	75.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	3.50	—	4.50
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton		—	
Ferrosilicon, 50 per cent, contract	ton	153.00	—	160.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.35	—	2.40
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.50	—	....
Ferrovanadium, f.o.b. works	lb.	....	—	....

Ores and Semi-finished Products

Chrome ore, 45 per cent minimum, f.o.b. Cal. per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit	ton	1.40	—	....
Coke	ton	6.00	—	7.00
Manganese ore, 48 per cent and over, per unit	ton	1.20	—	....
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	1.25	—	1.50
Tungsten, Scheelite, per unit of WO_3	ton	25.50	—	....
Tungsten, Wolframite, per unit of WO_3	ton	23.00	—	....
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	....
Pyrites, foreign	unit	.17	—	....
Pyrites, domestic	unit	.28	—	.30½

Plant Supplies

BUILDING MATERIALS

Common clay bricks	M	13.00	—	14.00
Hollow tile, 4 x 12 x 12	M	60.00	—	....
Hollow tile, 12 x 12 x 12	M	170.00	—	....
Lime	ton	16.50	—	....
Portland cement	bbl.	2.59	—	....
Single glass (82-lb.), 10 x 26-16 x 24		21.00	—	27.00
Double glass (164 lb.), 10 x 26-16 x 29		31.00	—	39.00
Yellow pine lumber	M	39.00	—	45.00
Fir lumber	M	38.00	—	53.00
Hemlock	M	24.50	—	40.00
Tarred felt (14-lb.sq.)	ton	68.00	—	....
Roofing pitch	ton	27.00	—	....
Asphalt coated roofing (35-55-lb.sq.)	sq.	1.60	—	2.45
Slate surfaced asphalt shingles	sq.	5.25	—	5.50
Corrugated galvanized iron	ton	109.00	—	127.00
Putty	100 lb.	6.25	—	....
Red oxide (Fpte. Copperas)	100 lb.	15.00	—	20.00
Native red oxide	100 lb.	3.25	—	8.00
Red metallic paint	100 lb.	1.20	—	1.50
White lead in oil	100 lb.	11.84	—	14.00
Red lead in oil	100 lb.	12.28	—	14.50
Zinc oxide (dry)	100 lb.	13.00	—	14.50
Zinc oxide—leaded	100 lb.	9.00	—	10.00
Yellow ochre	100 lb.	1.50	—	10.00
Ultra marine blue	100 lb.	14.00	—	50.00
Prussian blue	100 lb.	135.00	—	150.00
Chrome green	100 lb.	40.00	—	70.00
Paris green	100 lb.	43.00	—	49.00
Mineral black	100 lb.	1.75	—	2.25
Powdered bone black	100 lb.	5.50	—	12.00
Lampblack	100 lb.	15.00	—	45.00
Gas carbon	100 lb.	16.00	—	25.00
Mexican petroleum pitch	100 lb.	1.00	—	2.00
Gilsonite	100 lb.	2.00	—	2.50
Coal tar pitch	100 lb.	.60	—	1.25

STRUCTURAL IRON

Blue annealed sheet iron	ton	84.00	—	89.00
Black sheet iron	ton	96.00	—	104.00
Galvanized iron	ton	105.00	—	135.00
Tern plate, 8-lb. coating	ton	150.00	—	....
Tern plate, 15-lb. coating	ton	177.50	—	....
Tern plate, 25-lb. coating	ton	200.00	—	....
Tern plate, 40-lb. coating	ton	240.00	—	....
Tin plate, prime	ton	155.00	—	....
Tank plates	ton	65.00	—	65.00
Beams, channels, angles, T's, Z's	ton	60.00	—	70.00
Rivets	ton	88.00	—	92.00
Steel pipe, ¼ to 3-inch	ton	51.00	—	....
Bar iron and steel	ton	60.00	—	70.00
Chain (1 inch proof coil)	ton	150.00	—	....
Nails, bolts, nuts, washers	ton	70.00	—	80.00
Tool steels, special alloys	ton	300.00	—	500.00
Bessemer pig iron	ton	36.60	—	....
Bessemer steel	ton	47.50	—	....
No. 2 foundry	ton	37.90	—	....
Steel billets (4 x 4)	ton	47.50	—	....

POWER HOUSE SUPPLIES

Steam packing, rubber duck	lb.	.99	—	1.10
Asbestos, high pressure	lb.	1.76	—	....
Asbestos, wired	lb.	1.30	—	....
Asbestos, graphited braid	lb.	1.21	—	....
Asbestos, wick	lb.	.75	—	....
Rubber, sheet	lb.	.66	—	....
Cup grease	lb.	.07	—	....
Transmission grease	lb.	.07	—	....
Axle grease	lb.	.04½	—	....
Gear grease	lb.	.04½	—	....
Cotton waste	lb.	.08½	—	.11
Hose, underwriters, 2½ in	ft.	.75	—	....
Hose, air, ¾ in	ft.	.50	—	.60

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

CONGRESS JUNCTION—The Octaves Mines Co. will build a 200-ton gold reduction plant.

GLOBE—J. F. Mayer, City Clerk, will receive bids until Dec. 5, for building sanitary sewers and sewage disposal plant. Work includes two Imhoff tanks, two sludge beds, one chlorinator house, etc. Benham Engineering Co., Colcord Bldg., Oklahoma, City, engineer.

OATMAN—The Arizona Mossback Mines Co. will build a 250-ton crushing and cyaniding mill. Estimated cost, $250,000.

Arkansas

ANDERSON—The Everton Mining & Development Co. will build a 300-ton washing plant.

BATESVILLE—The Reeves Mines will install machinery for a 300-ton washing plant.

California

ATASCADERO—E. C. Lewis will build a large dehydrating plant here, also several smaller plants at various points in San Luis Obispo County.

LOS ANGELES—The New Ellen Potash & Chemical Co., Van Nuys Bldg., will build a castor oil mill, including three-story concrete building. F. L. Stiff, architect, Van Nuys Bldg., preparing plans.

Colorado

BRIGHTON — The Loveland Natural Food Co. will build a dehydration plant here.

GREELEY—The Loveland Natural Food Co. will build a dehydration plant here.

LONGMONT — The Loveland Natural Food Co. will build a dehydration plant here.

LOVELAND — The Loveland Natural Food Co. will build a dehydration plant here.

Connecticut

HARTFORD—The Hartford City Gas Light Co., 561 Main St., has awarded the contract for the construction of extensive alterations to its building, to J. H. Grozier Co., 17 Van Dyke Ave. Project includes the erection of a laboratory, offices, etc.

District of Columbia

WASHINGTON — The Department of Commerce will receive bids until Dec. 4 for the construction of a fishery products laboratory at 6th and B Sts. Address Commissioner of Fisheries.

WASHINGTON—The Bureau of Yards & Docks, Navy Department, will build a laboratory building at the Naval Hospital. Estimated cost, $14,000. Noted Nov. 30.

Florida

FORT MYERS—The American Fish Products Co. has awarded the contract for the construction of a two-story, 50 x 100 ft. and eight 30 x 60 ft. buildings, and will install dehydrating, canning, processing and fertilizer machines. G. S. Stone, manager.

TAMPA—The Florida Glass Co. will build a new plant. Estimated cost, $150,000. E. J. Early, Orlando, president.

Illinois

CHICAGO—The American Steel & Machine Co., Mansfield, will build a two-story, 36 x 72 ft. laboratory. Estimated cost, $60,000. O. H. Raeder, 20 West Jackson Blvd., architect.

CHICAGO—The Barrett Co., 2900 Sacramento St., will improve its plant for the manufacture of coal tar products. Estimated cost, $20,000.

CHICAGO—The Chicago, Smelting & Refining Co., 1326 West 51st St., will remodel the plant purchased from the Hills, Benedict Linseed Oil Co., Loomis St., and will remodel same for its own use.

CHICAGO—The Wisconsin Steel Co., 106th St. and Torrance Ave., will build a two-story factory for the manufacture of by-products of coke. Estimated cost, $65,000.

Kentucky

LOUISVILLE—The Clay Chemical Co., 1402 Lincoln Bank Bldg., will install a charcoal plant, to include plant for evaporating salt. R. E. Gordon, president.

Maryland

HAGERSTOWN—The Pangborn Corp. will build a two-story, 40 x 70 ft. laboratory and sand house. Estimated cost, $8000. W. L. Middleknauff, 565 Washington St., superintendent.

HAGERSTOWN—The Water Board will enlarge its filtration beds at Bridgeport pumping plant to secure improved facilities for treating water from Antietam Creek. J. McPherson Scott, president.

INDIAN HEAD—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a nitrate plant, to the De-Kempe Construction Co., 161 Nesbit St., Union Hill, N. J. Estimated cost, $180,000.

Michigan

GRAND RAPIDS — The Construction Division of the War Department, Washington, D. C., has awarded the contract for the construction of a picric acid plant to the Owens & Ames Kimball Co. Estimated cost, $1,000,000.

GRAND RAPIDS—The War Department, Washington, D. C., has appropriated $1,500,000 for the construction of a sulphuric acid plant to be located here.

HAMTRAMCK—The Michigan Smelting & Refining Co. will build a two-story, 110 x 140 ft. addition to its plant. Estimated cost, $100,000.

PORT HURON—The Port Huron Sulphite Pulp & Paper Co. will build an addition to its plant.

Minnesota

CALUMET—The Inter-State Iron Co. will build a two-unit iron ore washing plant having a daily capacity of 1000 tons.

DULUTH—The Minnesota Steel Co., Gary St., will build a steel plant. Estimated cost, $15,000,000. G. L. Price, vice-president.

IRONTON—The Mille Lacs Mine has awarded the contract for building a new shop and laboratory to A. G. Gionet.

Missouri

ST. LOUIS—The St. Louis Surfacer & Paint Co., Arlington St. and Terminal Belt Line, will build an addition to its plant.

Montana

PHILIPSBURG—The Beaver Mining Co. will build a new manganese mill. Estimated cost, $25,000.

New Jersey

CRANFORD—C. E. Kaltenbach, 56 Bigelow St., Newark, will build a chemical laboratory here.

NEWARK—The Rubber & Celluloid Products Co., 56 Ferry St., has awarded the contract for reconstructing its two-story, 40 x 400 ft. factory, which was recently destroyed by fire, to the American Concrete Steel Co., 31 Clinton St.

ORANGE—The Radium Luminous Material Corp., Alden St., will build a one-story research laboratory addition. R. R. Rowland, superintendent.

New York

BUFFALO—The Buffalo Union Furnace Co., Hamburg St., will build an addition to its plant.

BUFFALO—G. Elias & Bros., Inc., 965 Elk St., will build a gas producer plant.

BUFFALO—The National Aniline & Chemical Co., Edgewood Arsenal, will build an addition to its plant here. W. T. Miller, secretary.

LOCKPORT—The Isco Chemical Co. will build an addition to its plant. Estimated cost, $5000. Evan C. Speiden, vice-president, in charge.

NEWBURGH—The G. Washington Coffee Refining Co., 147 41st St., Brooklyn, has awarded the contract for the construction of a coffee refining plant on Mill and William St., to the Austin Co., 217 Broadway, New York City.

NEW YORK—The Metal Disintegrating Co., 3 South William St., will rebuild its factory, recently destroyed by fire. Plans call for four two-story, 200 x 400 ft. buildings.

NEW YORK—Milliken Brothers, Woolworth Building, has purchased the plant of the James H. Young Stone Co., 136th St. and East River, also the adjoining property, and will build a one-story, 50 x 100 ft. galvanizing plant. Estimated cost, $25,000. J. E. Jennings, vice-president.

NIAGARA FALLS—The Electro Metallurgical Co., Union St., will build an addition to its plant for the manufacture of ferro-alloys. Estimated cost, $14,000.

NIAGARA FALLS—The Republic Carbon Co., Sugar St. and New York Central R. R., has awarded the contract for the construction of a plant consisting of four buildings, to the Lackawanna Bridge Co., Bell and Abby Sts.

POUGHKEEPSIE—The Palatine Aniline & Chemical Co., North Water St., will build an addition to its plant. Estimated cost, $40,000. C. O. Tertwilliger, president.

Ohio

RAVENNA—The Oak Rubber Co., South Prospect St., will build a three-story addition to its plant on Chestnut St.

Oklahoma

CARDIN—The Burnham Mining Co. will build a 250-ton mill. E. Van Drevelt, superintendent.

Pennsylvania

BELLEFONTE—The American Lime & Stone Co. will build a new dehydrating plant. Estimated cost, $400,000. A. C. Morris, president.

BETHLEHEM—The Air Reduction Co., 177 Pacific Ave., Jersey City, N. J., has awarded the contract for the construction of a plant here, to James Mitchell, Inc., 76 Montgomery St., Jersey City, N. J. Estimated cost, $50,000.

CLARENDON—The Tiona Refining Co. will build an addition to its oil plant. Estimated cost, $500,000. R. W. Lavery, 120 Penn Ave., East Warren, superintendent.

OAKMONT—The Edgewater Steel Co., Edgewater Station and Allegheny Valley R. R., has awarded the contract for the construction of a one-story, 100 x 125 ft. factory, to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. Estimated cost, $60,000.

WEST BRIDGEWATER—The Chippewa Oil Co., Beaver, will build a refinery on Market St. to include pipe line, etc. Total estimated cost, $60,000.

Rhode Island

PROVIDENCE—The Providence Dyeing, Bleaching & Calendering Co., 52 Valley St., has awarded the contract for the construction of a two-story, 27 x 56 ft. bleachery addition to its existing building to H. E. Matthewson, 97 Peace St. Estimated cost, $7500.

Tennessee

KINGPORT—The city has awarded the contract for the installation of a filtration plant to the Pittsburgh Filter Manufacturing Co., Farmers Bank Bldg., Pittsburgh, Penn. Estimated cost, $50,000.

Texas

HOUSTON—The city will build a sewage disposal plant. Estimated cost, $75,000. E. E. Sands, city engineer.

PORT NECHES—The Magnolia Petroleum Co., Galveston, will build an oil refinery on a site recently purchased here.

Utah

CASTLEGATE—The Utah Fuel Co. will build a water purification plant, to include rapid sand filter, storage tanks, pumping plant and pipe lines. Estimated cost, $40,000.

Virginia

NORFOLK—The city will improve its water-works, to include replacing of four wooden filters, overhauling of wooden filters, erection of filter shed, repairs and alterations to alum house, etc. Total estimated cost, $70,000. Walter H. Taylor, city engineer.

NORFOLK—The Manganese Steel Casting Co. has awarded the contract for the construction of a steel casting plant at Newton, near here, to the General Contracting Co., 409 Citizens Bank Bldg. Estimated cost, $300,000.

Washington

SEATTLE—The Smelters Steel Co., White Bldg., will build a one and one-half story, 90 x 100 ft. timber smelter plant in Commercial Waterway District No. 1. F. W. Grant, Mehlhorn Bldg., architect.

West Virginia

AFFINITY—The E. E. White Coal Co. will build a water purifying plant at its mine here. E. T. Luty, superintendent.

Wisconsin

CARROLLVILLE—The Newport Chemical Works will build a manufacturing plant addition.

CUBA CITY—The Connecting Links Mining Co. will build a lead and zinc concentrating plant having a daily capacity of 100 tons. Estimated cost, $40,000.

MILWAUKEE—The Sewerage Committee, City Hall, will construct a sewage disposal plant on Jones Island. Estimated cost, $1,000,000.

NEENAH—The Neenah Brass Works has awarded the contract for the construction of a factory and office building to C. R. Meyers & Sons Co., 50 State St., Oshkosh. Estimated cost, $16,000.

PESHTIGO—The Peshtigo Pulp & Paper Co. will build a paper mill. G. Maurer, superintendent.

WEST ALLIS—The Modern Steel Treating Co., 619 38th Ave., will rebuild its one-story, 30 x 80 ft. factory. G. W. Esau, president. Max Fernekes, 375 Summit Ave., Milwaukee, architect.

British Columbia

VANCOUVER—The B. C. Sugar Refining Co., Ltd., foot Rogers St., has awarded the contract for the construction of a one-story, 40 x 117 ft. fuel plant on Prince Edward St., to the Northwest Steel Co., Vancouver. Estimated cost, $39,000.

YALE—The Mary Reynolds Mining Co. will build a concentration mill and contemplates developing capacity from two to three carloads of ore per month. Robert R. Hedley, superintendent.

Ontario

TORONTO—The Liquid Air Co., Ltd., 16 Boler Ave., will build a two-story mill and brick factory addition. Estimated cost, $20,000.

Quebec

MONTREAL—The Beaver Oil Co., 900 De L'Espe St., will rebuild its oil plant, recently destroyed by fire entailing a loss of $10,000.

Manufacturers' Catalogs

THE AUSTIN COMPANY, Cleveland, Ohio, industrial engineers and builders, has issued a well-illustrated 64-page catalog entitled "The Austin Book of Buildings" (No. 5) which is just off the press, covering the service performed today by this company. A definition of the Austin method is first given, its chapters covering the ten Standard building units, railway Standard units, combinations of Standards, specifications, industrial building service, its equipment service, and export service and a list of owners of these buildings which includes among others an engineering building, sales building, administration building, research laboratory, working building, power house garage, purchasing and service buildings built for the Mazda Lamp Works at Cleveland. Detailed drawings of all cross-sections of floor plans, side elevations, front elevations, etc., are given together with specifications for each standard and exact uses for each type of building.

THE PANGBORN CORPORATION, Hagerstown, Md., calls attention to Bulletin No. 50 on sand blast principles and data with illustrations, showing work advantageously handled by the different types of machines.

R. H. BEAUMONT COMPANY, Philadelphia, Pa.: Catalog 38, describing and illustrating the Beaumont drag scraper system for the ground storage of coal.

PAGE STEEL AND WIRE COMPANY, Monessen, Pa., "Aristos 'Copperweld' Copper Clad Steel Wire" is the title of a very attractive catalog which presents information pertaining to the properties of this steel wire. The electrical and mechanical properties of this wire and solid copper wire are presented in the wire tables in parallel columns; numerical values of physical constants and other data are given. This catalog is well illustrated.

DELAVAL STEAM TURBINE COMPANY, Trenton, N. J.: Bulletin N on centrifugal boiler-feed pumps.

LIGHT FOR INDUSTRIAL PLANTS: The General Electric Company Edison Lamp Works has published bulletin 43410 containing the latest information as to the correct methods of lighting industrial plants, especially those devoted to the manufacture of clothing for our fighting forces at home and abroad. The bulletin is well illustrated, showing various lighting schemes most suitable for industrial purposes, and the facts are brought out that to conserve the employees' health, to save coal, to increase the output and to keep the workers contented, it is necessary that a shop be well illuminated according to modern methods.

THE MERRILL METALLURGICAL COMPANY, San Francisco, Calif., has just issued an attractive bulletin on "The Merrill Precipitation Process" which gives a brief description of methods and apparatus used in precipitating gold and silver from cyanide solutions by means of Merrillite, zinc dust and other precipitants. This bulletin is very well illustrated.

THE ARMSTRONG CORK COMPANY, Pittsburgh, Pa., announce three new publications, viz., "Maintaining Morale," "Nonpareil High Pressure Blocks and Cement," and "Linotile Floors." Copies of these publications will gladly be sent to all who are interested.

THE WALTER A. ZELNICKER SUPPLY CO., St. Louis, Mo., has just issued Bulletin 249 and 252 which is free to the trade.

THE JEFFREY MANUFACTURING CO., Columbus, Ohio, calls attention to Catalog No. 175, which is an attractive 80-page booklet on Jeffrey Belt Conveyors. Although compiled essentially for the purpose of promoting the advantages of using the Jeffrey belt conveyor, the purchaser's requirements for information upon those elements in the application of the belt conveyor which mean for satisfactory service, have been thoroughly covered in every detail. The best in belt conveyor practice has been collected and printed in this catalog, the scope of which may be gathered from the following subjects, presented in a style, both interesting and instructive: Early types of belt conveyors; improvements in type for better service; industries using pull; general tables of belt capacities; belt-conveyors; condensed data for the busy engineer; belt tension and horsepower pull; general tables of belt conveyors; belting facts in widths, plys and covers; protecting the life of the conveyor belt; curve of belt from horizontal to incline; various forms of belt conveyor drives; spacing of conveyor parts for best service; methods of loading and unloading belts; Jeffrey belt conveyor parts; conveyor belting of various kinds; unloading trippers and installation views; rules for using "Standard" conveyors; tabulated list of the "Standard" conveyors; general dimensions for installing "Standard" conveyors; tabulated weights of various materials; Jeffrey belt conveyors in many industries.

THE CUTLER-HAMMER MFG. CO. has recently issued an 8-page booklet entitled, "Facts," which describes and illustrates the Dean valve control and its application to large valves. Special attention is called to the fact that by the application of the Dean valve control to water mains at strategic points a great deal of the damage caused by bursting water mains may be averted. This valve control consists of a high torque motor which opens and closes the valve gate, a limit mechanism which automatically disconnects the motor at the completion of the gate travel and one or more remote control stations from which the valve can be operated. The valve operating mechanism can be attached to the valve while it is in service and without affecting the service. This control system can also be adapted to large screw type valves and may be used for either municipal or industrial applications where it is desirable to open and close the valve rapidly or to have the control of the valve located somewhat distant from the valve itself. This company also calls attention to an envelope folder entitled, "C-H Standard Attaching Devices," and two descriptive leaflets illustrating and describing C-H soldering irons and C-H automatic safety racks for electric soldering irons, which are known as Publications 403 and 404.

THE BROWN HOISTING MACHINERY COMPANY, Cleveland, Ohio: Catalog D-1919 on Brownhoist trolleys, tramrail systems, hand traveling cranes, electric hoists, monorail man-riding trolleys, crabs and winches and portable floor cranes. This 56-page catalog is well illustrated and describes the apparatus mentioned above.

BEAUMONT MFG. CO., Philadelphia, Pa.: Catalog 37, giving descriptions, illustrations and dimensions of standard Beaumont gates for controlling the flow of granular material from bunker. The design of ash pits under boilers and the correct gate to use for this purpose are illustrated.

THE ACID PROOF CLAY PRODUCTS CO., Akron, Ohio: Catalog C is a new 62-page booklet on "Vitric" acid-proof chemical stoneware. This booklet is well illustrated and gives details of its many designs of apparatus.

THE CRESCENT BELT FASTENER CO., N. Y. C., has just published a 24-page booklet, entitled "Gone Again," which is written in the way of a "movie" comedy. It will be gladly sent with full technical and practical information to anyone interested, who requests it from this company's Sales Department, 381 Fourth Avenue, New York City.

THE STEERE ENGINEERING CO., Detroit, Mich., calls attention to Bull. 34, which illustrates and describes gas valves and welded steel pipe. A supplement is enclosed which shows special shapes that its machine shop is equipped to design and build.

New Publications

ORGANIZATION CHARTS, May, 1917-1918. Prepared by the Information Department, May 1, 1918, The Woman's Committee of the Council of National Defense, Washington, D. C.

USING BULK CEMENT ON CONCRETE ROAD WORK. By J. R. Schoonmaker. A four-page pamphlet published by the Portland Cement Association.

NEW BUREAU OF MINES PUBLICATIONS: Bulletin 156, The Diesel Engine, Its Fuels and Its Uses. By Herbert Hass; Technical Paper 190, Methane Accumulations from Interrupted Ventilation, with special reference to coal mines in Illinois and Indiana. By Howard I. Smith and Robert J. Hamon. Technical Paper 205, Saving Coal in Boiler Plants. By Henry Kreisinger; Bulletin 127, Gold Dredging in the United States. By Charles Janin.

NEW UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS: Building Operations in the Larger Cities in 1917. By Jefferson Middleton. (Mineral Resources, 1917, Part II), published Sept. 11, 1918; 1:4 Chromite in 1917. By J. S. Diller. (Mineral Resources, 1917, Part 1), published Aug. 8, 1918; 11:9 Slate in 1917. By G. F. Loughlin. (Mineral Resources, 1917, Part II), published July 30, 1918; 11:10 Feldspar in 1917. By Frank J. Katz. (Mineral Resources, 1917, Part II), published Aug. 7, 1918; 11:11 Gems and Precious Stones in 1917. By Waldemar T. Schaller. (Mineral Resources, 1917, Part II), published July 29, 1918; 11:12 Salt, Bromine and Calcium Chloride in 1917. By Ralph W. Stone. (Mineral Resources, 1917, Part II) published Aug. 10, 1918; 11:14 Asbestos in 1917. By J. S. Diller. (Mineral Resources, 1917, Part II), published Sept. 18, 1918; 11:15 Sand-Lime Brick in 1917. By Jefferson Middleton. (Mineral Resources, 1917, Part II), published Aug. 29, 1918; 11:16 Silica in 1917. By Frank J. Katz. (Mineral Resources, 1917, Part II), published Sept. 13, 1918; 11:17 Abrasive Material in 1917. By Frank J. Katz. (Mineral Resources, 1917, Part II), published Sept. 24, 1918; 11:35 Coal in 1916. By C. E. Lesher. (Mineral Resources, 1916, Part II), published Aug. 17, 1918.

THE HUMAN SIDE OF MINING ENGINEERING. An address by James Furman Kemp, professor of geology, Columbia University, New York City, which is the annual commencement address delivered before the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., and published by this University under date of June, 1918.